COMMONWEALTH OF VIRGINIA

SHENANDOAH AND POTOMAC RIVER BASINS

TRIBUTARY NUTRIENT REDUCTION STRATEGY

December 1996

Virginia Secretary of Natural Resources
Virginia Chesapeake Bay Local Assistance Department
Virginia Department of Conservation and Recreation
Virginia Department of Environmental Quality

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EXECUTIVE SUMMARY

Water quality degradation caused by nutrient over-enrichment has played a key role in the decline of the living resources of the Chesapeake Bay and its tributaries. To address this problem, the Chesapeake Executive Council signed the 1987 Chesapeake Bay Agreement which included a commitment to reduce the controllable loads of phosphorus and nitrogen entering the Bay by 40% by the year 2000. The Council, by signing an amendment to that Agreement in 1992, also agreed to develop and implement tributary-specific strategies for each of the Bay's major tributaries. These strategies are designed to meet the main-stem nutrient reduction goals, achieve the water quality requirements necessary to restore living resources in both the main stem of the Bay and its tributaries, incorporate public participation in the strategy process, and advance both cost-effectiveness and equity. This *Shenandoah and Potomac River Basins Tributary Nutrient Reduction Strategy* (Strategy) was developed in response to those commitments.

The Commonwealth has been working on the Strategy since 1992. In 1993, Virginia's natural resource agencies produced a discussion paper on reducing nutrients from nonpoint sources (runoff from agricultural and urban lands) and point sources (discharges from municipal and industrial wastewater treatment plants). Strategy development became a major initiative of the Commonwealth in 1994, and an actions and options document was produced in the fall of that year. Both of these documents were discussed at public meetings and received extensive comment. In August 1995, a *Draft Potomac Strategy* was published in response to the public input received. This draft promoted a strategy approach centered on local initiatives.

In order to strengthen the state's partnership with localities and citizens, the Secretary of Natural Resources invited the elected local government officials throughout the Shenandoah and Potomac River basins to be personally involved in an assessment process that would be conducted in four regions of the Shenandoah-Potomac basin. It was stressed to local officials that their participation implied no commitment to implement or fund a nutrient reduction strategy. The purposes of the assessment were to confirm progress to date, quantify local nutrient reduction programs, and ask local officials and stakeholders to identify additional actions appropriate for each region so the basin goal of a 40% reduction could be achieved.

As this assessment process was initiated, the 1996 General Assembly incorporated the Commonwealth's tributary strategies program into state law, in Chapter 5.1 of Title 2.1.

The assessment process produced important information on practical, cost-effective approaches to nutrient reduction that forms the core of this Shenandoah and Potomac River Basins Strategy. The regional assessments describe what actions each region recommends be done to achieve significant reductions in nutrients at the local level along with recommendations for how they could be accomplished.

The results of these assessments and other updated information and options were compiled into the Final Comment Draft of the *Shenandoah and Potomac River Basins Tributary Nutrient Reduction Strategy* (October 1996). The October 1996 draft was mailed and delivered to over 1500

persons, organizations and governments in the Shenandoah and Potomac River basins. Written comments were requested in the October 1996 draft Strategy, and also at five public meetings that were held. Approximately forty written comments were received on this draft, and these comments and recommended changes were considered in the preparation of this document.

The following table presents the percent changes in nutrient loads in comparison with the 1985 base load conditions to show how far we have come in nutrient reduction, projections for the year 2000 under current and planned programs, the expected level of nutrient reductions achieved under the regional assessment recommendations, and what can be achieved under full implementation of this Strategy.

Total Nutrient Loads for Virginia's Shenandoah-Potomac River Basin
Percent Change in Comparison with 1985 Base Load

	NITROGEN	**PHOSPHORUS**
Progress Through 1994	-9%	-27%
Projections for the Year 2000 (based on current & planned programs)	-11%	-28%
Reductions from Implementation of Regional Assessments	-37%	-36%
Additional Potential Strategy Reductions	-41%	-40%

Between 1985 and 1994, a significant amount of progress was achieved in reducing phosphorus. For nitrogen, a slight increase in the point source load offset the gains that were achieved through nonpoint source programs. However, holding the point source nitrogen load to a two percent increase was an accomplishment since the total volume of wastewater discharged in the basin increased nearly 20% between 1985 and 1994.

Through the year 2000, the nutrient loads are projected to remain relatively unchanged in relation to the 1994 levels. The loading reductions accomplished through the implementation of ongoing programs will essentially be offset by increases in loads due to growth.

The regional assessments focus on loading reductions that are practical, cost-effective and make sense for the localities in each of the regions. For example, the assessments for the Southern and Northern Shenandoah regions focus almost entirely on reducing agricultural nonpoint source loads. In the Northern Virginia region, most of the reductions result from upgrading the major wastewater treatment plants that serve the large population in that region.

As shown in the table above, the sum of the actions recommended in the regional assessments achieves 36% reduction for phosphorus and 37% reduction for nitrogen, but does not reach 40% goal for the basin. Of the four regions, only Northern Virginia's assessment fails to meet the 40% goal by a significant amount. There are several reasons for this. First, a considerable amount of nutrient

reduction, especially for point sources of phosphorus, was achieved in Northern Virginia prior to 1985, the year designated as the base year by the Chesapeake Bay Program Executive Council in 1987. Second, reducing urban nonpoint source loads by a significant amount, such as the 40% goal, is very difficult and expensive.

The estimated cost to install all of the nutrient reduction controls recommended in the four regional assessments is approximately $95 to $100 million. Under current technologies, additional Strategy reductions to the 41% level (nitrogen) and 40% level (phosphorus) could cost an additional $34 to $67 million.

The October 1996 draft of the Strategy proposed that the final 4% nutrient reduction gap be closed through the implementation of nutrient removal technology at all of the larger municipal wastewater treatment facilities across the Shenandoah-Potomac basin. This proposal was not supported by local officials in the Shenandoah Valley and Lower Potomac region, who believe that it unfairly placed the burden of closing the nutrient gap on areas of the basin that had worked cooperatively with the state to meet their regional nutrient reduction target. In addition, it would substantially diminish the capability of these areas to reserve future nutrient reduction measures that would help maintain their regional nutrient reduction caps as the population grows.

In the final Strategy, these sewage treatment plant retrofits are retained, as a technological option to achieve the full 40% reduction for the basin as a whole, although a fair application of the 40% reduction would preclude this option from being implemented until all regions had met their nutrient reduction targets. These measures are among the least cost-effective projects in the Strategy, and would in any case be among the last projects to be funded. As implementation proceeds, and with the benefit of more experience, newer technology and better science, future progress reports will need to revisit the question of whether these measures are needed. The concept of nutrient trading could allow for greater innovation in areas that seek more cost-effective reductions to achieve their share of the basin-wide reduction goal.

In addition to the issue of funding the nutrient reduction actions identified in the Strategy, there are other implementation issues. A vast majority of local officials and citizens stated that the Strategy should not impose new regulatory requirements. In response to that concern, the Strategy includes a framework for implementing nutrient reductions at wastewater treatment plants, that receive cost-share funds, outside of the standard regulatory process. A point source implementation hierarchy offers two levels of state/local partnership that allow owners of these treatment plants the opportunity to operate any nutrient reduction technology outside of the permit process, as long as they can demonstrate that they are achieving sufficient nutrient reductions. The Strategy makes it clear that the Commonwealth prefers working in a voluntary, cooperative approach, but the choice remains a local decision.

Throughout the entire Strategy process, a primary concern was the cost of the nutrient reductions needed to meet the goal. The Strategy summarizes the financial assistance currently available at the state level for Strategy implementation. Local officials made very clear that dollars taken out of their communities in the form of state and federal taxes should be a major source of funding for this program. The Commonwealth will seek to maximize the return of federal tax dollars

to support this program.

Governor Allen is presenting to the General Assembly a broad-based budget initiative to begin tributary restoration and Strategy implementation and to demonstrate strong support for the Commonwealth's commitment. In full support of the partnerships and involvement of local governments, stakeholders, interest groups and citizens in the Strategy process, the Governor proposed in his budget to the 1997 General Assembly that $11 million be targeted for Strategy implementation. This money, along with funds gained through a proposed Chesapeake Bay tax check-off, would be collected within a Chesapeake Bay Tributaries Restoration Trust Fund and distributed to nutrient reduction projects, to include point source and nonpoint source control practices. In addition, the Governor is proposing that $8 million be added to Virginia's Wastewater Revolving Loan Fund for the purpose of increasing low-interest loan capability for improvements to wastewater treatment plants. The $8 million will leverage $44 million in federal funds for a total package of $52 million that can also be used statewide for the local share of nutrient reduction and other water quality upgrades.

Through this initiative, the Governor is recommending that the Commonwealth take a significant first step toward the 40% nutrient reduction goal and set the stage for sound, prioritized funding of identified nutrient reduction practices. This approach will allow for continued fine-tuning of the Strategy as experience is gained through implementation and as advances are made in the area of nutrient reduction technology.

If the current budget surplus is returned to the people, there would be more money available in local communities to invest in initiatives that would reduce nutrient loads. In the final analysis, citizens and their elected officials must decide at which level of government and for which projects they wish their dollars to be used, how quickly they wish to achieve the reduction goal, and how much they wish to invest in the health of their rivers and the Bay.

VIRGINIA'S SHENANDOAH AND POTOMAC RIVER BASINS TRIBUTARY NUTRIENT REDUCTION STRATEGY

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ACKNOWLEDGMENTS

Since Virginia undertook the Potomac Tributary Strategy initiative in 1992, many local governments, soil and water conservation districts, planning district commissions, citizen groups, industry associations, conservation groups, treatment plant operators, farmers, university staff, state agencies, state legislators and others have played key roles in bringing the Strategy to completion.

First and foremost, local governments and soil and water conservation districts throughout Virginia's Shenandoah and Potomac River basins deserve recognition for their participation in the Strategy process and for their willingness to work in partnership with the Commonwealth to reduce nutrient pollution. This effort required substantial foresight and dedication of time and effort on the part of these local officials and staff. It included numerous meetings and involved coordination with a wide range of citizens and stakeholders within each of their respective jurisdictions and districts.

Industry associations, including the Virginia Poultry Federation, the Virginia Farm Bureau and the Virginia Association of Municipal Wastewater Agencies, have provided leadership and commitment to finding voluntary methods for reducing nutrient pollution in the Potomac basin. Their efforts have demonstrated the value of a cooperative approach to conservation and water quality protection in Virginia and have inspired other groups and citizens to consider the contributions that they could make to this initiative.

Citizen groups and conservation organizations deserve mention for their important involvement in attending Potomac Tributary Strategy meetings and for remaining committed to the health and quality of the Shenandoah and Potomac Rivers and the Chesapeake Bay.

Farmers throughout the Shenandoah-Potomac River basin have played a major role in reducing nutrient pollution as a result of their stewardship of soil and water. This stewardship ethic provides an important foundation for much of the continued success of the Potomac Strategy.

Under the leadership of Secretary Becky Norton Dunlop, Virginia's natural resources agencies have provided technical direction, information and assistance for the development of the Potomac Strategy. The Chesapeake Bay Local Assistance Department, the Department of Conservation and Recreation and the Department of Environmental Quality primarily have served in this capacity. Other participating state agencies include the Department of Forestry, the Department of Agriculture and Consumer Services, the Marine Resources Commission, the Department of Game and Inland Fisheries, and the Cooperative Extension Service and Department of Agricultural and Applied Economics of Virginia Polytechnic Institute and State University.

Through his budget initiative, Governor Allen has supported the locally-based Strategy development process. He has demonstrated that environmental protection can be accomplished through grass-roots initiative and that government can still be responsive to the will of the people.

PREFACE

This document is Virginia's *Shenandoah and Potomac River Basins Tributary Nutrient Reduction Strategy*. The purpose of the Strategy is to improve water quality and help restore living resources in Chesapeake Bay and its tributaries by reducing the level of nutrients (phosphorus and nitrogen) entering the Shenandoah and Potomac Rivers. The goal is to achieve and maintain a 40% reduction of the controllable nutrient loadings into these rivers from point and nonpoint sources through measures that are practical, equitable and cost effective.

Nutrient reduction in the Shenandoah-Potomac basin has been a major initiative of the Commonwealth and its agencies since 1994. This initiative has included substantial technical work on the part of these agencies and coordination with citizens, stakeholders and local officials in the basin. The 1996 General Assembly passed House Bill 1411 which set forth a timetable for the completion of strategies for each of Virginia's Chesapeake Bay tributaries. Appendix A includes a copy of House Bill 1411. It also includes a number of reports and information that are required of each tributary plan under HB 1411. As set forth in HB 1411, the next step that must be taken is submission of the Shenandoah-Potomac Strategy to the General Assembly by January 1, 1997.

The Strategy began with the Chesapeake Bay Program initiative to improve water quality in the Bay and its tributaries by reducing specific nutrients. Virginia's natural resource's agencies next developed the background information necessary to better understand nutrient loadings in the Potomac basin and to frame possible solutions. The final and most important task was to gather the viewpoints and recommendations of Virginia's local elected officials, farmers, conservation groups, business interests and citizens from across the Shenandoah-Potomac basin to construct a final strategy based on local guidance. This approach ensures that the Strategy is tailored to protect the quality of local rivers and streams as well as the Chesapeake Bay.

In developing the Strategy, this bottom-up approach was implemented through an assessment process that called upon local decision makers to identify practical solutions for reducing nutrient loadings. The process included local government officials and interested parties throughout the basin. The result of this assessment process is the core of the Strategy. It sets forth the types and costs of nutrient reduction practices that participants in the process determined would be cost-effective, practical and equitable to implement under certain conditions, such as availability of cost-share funding and expanded technical assistance.

These practices include nutrient reductions from point sources (municipal and industrial wastewater treatment plants) and nonpoint sources (runoff from farms, residential land and other urban areas). The Strategy sets forth the estimated costs of installing those nutrient controls. It also presents information and reflects public input on possible means of financing those actions.

Estimates of nutrient loadings, reductions and costs are fundamental to the development of

the Strategy (Appendix B provides a general description of the Chesapeake Bay Modeling Program and Appendix C outlines methodologies used for nutrient reduction calculations). As with all estimates, the estimated nutrient loads and reductions presented in this document include varying degrees of accuracy. It is important to note that these estimates are based on state-of-the-art scientific research, water quality monitoring and computer modeling. The accuracy of these figures is sufficient to support the conclusions that are drawn from them and the benefits of implementing the Shenandoah-Potomac Strategy.

The Strategy describes the process that has led us to this point, the groups who have been involved in this process, the technical basis for data and other background information. It also outlines the process for how Virginia's continued efforts to achieve the Shenandoah-Potomac River basin nutrient reduction goal will be carried into the future. In addition, significant background information is contained in the four Potomac Strategy-related documents that have been produced previously by the Commonwealth. Copies of these documents can be obtained by contacting the Department of Environmental Quality or the Department of Conservation and Recreation at the addresses or telephone numbers listed below.

To ensure that the Strategy will be a dynamic document that responds to successes, new information, technological advances and the interests of Virginians, the Commonwealth will continue to receive public input on this Strategy. Please send comments to one of the addresses below, or contact Alan Pollock at (804) 698-4002 or Gary Waugh at (804) 786-5045.

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Attention: Alan Pollock
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Richmond, Virginia 23219

I. HOUSE BILL 1411 OF 1996

The 1996 General Assembly adopted House Bill 1411 (see Appendix A), which directed the Secretary of Natural Resources to continue to "*coordinate the development of tributary plans designed to improve water quality and restore the living resources of the Chesapeake Bay and its tributaries.*" The resulting Act was placed in *Virginia Code, Chapter 5.1 of Title 2.1*. The legislation focuses primarily on nutrient reductions and establishes the following schedule for the completion of each of the strategies:

Potomac River Basin.....	January 1, 1997
Rappahannock River Basin.....	January 1, 1998
York River Basin.....	January 1, 1998
James River Basin.....	January 1, 1998
Eastern and western coastal basins.	January 1, 1999

The sequential deadlines set forth for the development of the remaining tributary strategies elevate the importance of effective action being taken on the Shenandoah-Potomac Strategy. The level of success that is achieved through the Strategy will have a significant impact on the degree to which citizens, stakeholders, interest groups and local representatives continue their involvement in the tributary strategy process as it moves to the other river basins and coastal basins of Virginia's Chesapeake Bay watershed.

II. BACKGROUND AND INTRODUCTION

The Problem: Nutrient Pollution in Virginia Waters

The quality of water for human consumption and for aquatic habitat can be seriously affected by high levels of nutrients (nitrogen and phosphorus). Excess nutrients coming from point sources (wastewater treatment plants and industrial plants) and nonpoint sources (surface runoff from farms, residential lands and other urban areas) in the Shenandoah and Potomac River basins have an impact on local water quality as well as on the living resources of the Potomac River and the Chesapeake Bay. Excessive nitrate in drinking water (surface or ground water) can cause human health impacts. High levels of nutrients lead to increased algae populations, which can cause taste and odor problems in drinking water and adversely affect fish, oysters, crabs, underwater grasses and other aquatic life. As algae populations increase in local surface waters and further downstream in Bay waters, they block light from reaching underwater grasses. As algae die and sink to the bottom, their decay robs the water of oxygen, essential for fish, shellfish and other aquatic animals.

The Benefits of Reducing Nutrient Loadings

There are a number of expected benefits from implementing nutrient controls. The two most important of these are increasing the level of dissolved oxygen, essential to the survival of aquatic animals, and improving water clarity, vital for underwater grasses. As oxygen levels increase, a greater volume of water becomes available as habitat to fish and other aquatic animals. Beyond the direct benefit of increased habitat, nutrient reductions will lead to substantial benefits as a result of improvements across the food web. Improved oxygen levels translate into greater survivability for smaller organisms which serve as food for fish. Healthier stands of underwater grasses provide habitat for invertebrates and juvenile fish, which also offer numerous benefits as a food source.

Economic and operational benefits also accrue to farmers who implement practices that keep topsoil and nutrients on their farm and to wastewater treatment plants that implement a nutrient removal process such as biological nutrient removal (BNR).

Shenandoah and Potomac Tributary 40% Goal for Nutrient Reduction

As a signatory of the 1987 Chesapeake Bay Agreement, Virginia and other Bay Program jurisdictions are working to achieve a 40% reduction of the controllable nutrient load to the Bay by the year 2000. In response to a 1992 amendment to the Agreement that focuses nutrient reduction on the Bay tributaries, this Strategy has been developed to reach the goal in the Potomac basin. As opposed to a one-size-fits-all prescription, the tributary strategy approach allows nutrient reduction solutions in each basin to be considered and developed separately. The mixes of nutrient sources are different in the drainage basin of each of Virginia's Bay tributaries. Each has distinct characteristics, and each requires a unique combination of practices for meeting its nutrient reduction goal.

Impact of Shenandoah and Potomac River Nutrient Loads on the Chesapeake Bay

Technical studies leading to the 1992 amendment to the Bay Agreement yielded an important finding about Virginia's tributaries and their impact on Bay water quality. It was determined that the nutrient loads from the Potomac River basin and basins to the north had the greatest impact on conditions in the Bay, whereas the southerly river basins in Virginia, the Rappahannock, York, James and small coastal basins, contributed little, if any, to the low dissolved oxygen problems of the Bay. For this reason, Virginia embarked on a two-pronged approach to tributary strategies -- a concentrated effort in the Potomac basin to meet the 40% goal, and at the same time expanding monitoring and modeling programs in the lower tributaries to determine appropriate nutrient reduction goals needed to protect water quality within these tributary rivers themselves.

Past Success: Nutrient Reductions Achieved in the Shenandoah-Potomac Basin

Nutrient reductions and program developments that have occurred in the basin since 1985 have made significant progress toward meeting the Potomac basin 40% nutrient reduction goal. In the absence of action on this Strategy, and simply continuing existing programs, it is projected that nitrogen and phosphorus loadings into the Potomac by the year 2000 will be reduced by approximately 10% and 30%, respectively. As noted in the Preface, detailed information on many of these reductions and programs are contained in the Potomac Strategy-related documents that have been previously produced and are available from Virginia's natural resources agencies.

The Current Process: Locally-Based Identification of Nutrient Reduction Practices

Additional nutrient reduction practices that can help Virginia achieve the 40% nutrient reduction goal are presented in the Strategy. The selection of these practices was the result of four regional assessments that were conducted in the Shenandoah-Potomac basin (see Appendices H-K). The purpose of the assessments was to identify practical solutions for reducing nutrient loadings through local decision-making. The process included representatives of local governments, soil and water conservation districts, planning district commissions, wastewater treatment plant operators, conservation groups and farmers in order to link the development of the Strategy as closely as possible to the interests and concerns of stakeholders in the region. During the assessment, it was stressed to local officials that participating in the process implied no commitment to implement a nutrient reduction strategy nor to fund any part of a Strategy.

The assessment process was made more workable by dividing the basin into four regions: Southern Shenandoah, Northern Shenandoah, Northern Virginia, and Lower Potomac (see map on next page). This approach allowed state staff to assist local officials and others to explore nutrient reduction options within geographic areas that have similar land uses, industries, population densities and nutrient sources. The participants in this process identified the types of nutrient reduction actions and management practices that are most appropriate within each region, or locality, of the basin. The use of regions also reinforced the bottom-up approach of the tributary strategy process.

An important added benefit of the assessment process was the identification and, where possible, quantification of additional nutrient reduction efforts that were going on at the local level so that credit could be given for these local initiatives.

The Challenge: Decisions on Funding the Costs of Nutrient Reductions

The full success of this effort to restore water quality in the Bay and its tributaries depends on future actions and funding decisions that will determine whether the 40% nutrient reduction goal is achieved and maintained. For the Shenandoah-Potomac Strategy, these decisions can be distilled down to the choice of whether cost-share funding should be provided to two principal areas: implementing agricultural nonpoint source control practices, and installing nutrient control systems at wastewater treatment plants. At the crux of this decision is the question: "Who is responsible for implementing and paying for these practices?"

The probable costs of reducing the nutrient loads to the Potomac River are large. Depending on the combination of actions taken, the estimated capital and installation costs of achieving the 40% nutrient reduction goal for the Shenandoah-Potomac basin may total $95 to $100 million.

Determining how to meet those costs has been, and will continue to be, a cooperative process. State staff have worked with the participants in each of the four regions to address the issue of finding equitable and practical ways to meet those costs. Additionally, representatives of other selected interests have been consulted on this issue. The range of opinion and most common responses to this issue are reported in Section VII, Meeting the Costs of Nutrient Reduction.

Under a cost-share program, the most widely supported funding mechanism, a portion of the cost for a given practice is paid for by the farmer or the rate payers of a wastewater treatment plant. Other costs are provided through funds derived from a larger segment of the population. Throughout the Strategy process, the foremost perspective heard from citizens in the basin was one of mutual responsibility. The majority of people believe that to move forward on nutrient reduction will require more than placing the full burden for cleanup on any single group, and that equity must be a guiding principle in any implementation scheme.

An important example of the need for equity is the funding of agricultural best management practices (BMPs). Agricultural BMPs are some of the most cost-effective nutrient reduction practices available and they can have economic benefits for agriculture as well as for fisheries. Keeping topsoil and nutrients on farm fields and out of waterways is a benefit to the farmer and also to society; and it has been suggested that both should share in its responsibility. Through the Potomac basin regional assessments, agricultural BMPs were identified as cost-effective means for society to achieve nutrient reductions. However, none of the assessments recommended that the burden for paying for these practices should be placed solely on the agricultural sector.

III. BENEFITS OF POTOMAC RIVER NUTRIENT REDUCTIONS

The 1987 Chesapeake Bay Agreement committed the signatories to develop guidelines for the protection of habitats and water quality conditions necessary to support the living resources of the Bay. Consistent with these guidelines, there are a number of expected water quality benefits that will result from implementing nutrient controls. These include improved levels of dissolved oxygen, reductions in excess algal growth, increased light penetration into the water, and numerous related improvements in the overall health of the Bay and its living resources.

Increased Dissolved Oxygen

Dissolved oxygen (DO) is a major factor affecting the survival, distribution, and productivity of living resources in the Bay. Under normal conditions, the amount of available oxygen in the Bay ecosystem is affected by such things as salinity and temperature of the water. This system is also affected by nutrients. Excess amounts of nitrogen and phosphorus cause rapid growth of phytoplankton, creating dense populations, or blooms. In the shallow fringes of the Bay, these blooms block sunlight to the plants living in these areas. And throughout the Bay, as the tiny plankton die and decay, oxygen from the surrounding water is depleted as a result of the process of decomposition. This can lead to dangerously low oxygen levels that harm or even kill other aquatic life and create large areas of the Bay that are unsuitable for anything to live. Many parts of the Bay including the deep waters of the main stem lack any oxygen during the summer months and are, as a result, devoid of animal life. Therefore, benefits of reducing nutrients entering the Bay from its tributaries include controlling excess production of phytoplankton and the resultant reduction in dissolved oxygen and light penetration.

Complex state-of-the-art computer models were developed in order to estimate nutrient loads to the Bay and simulate water quality improvements in the Bay resulting from load reductions. A useful measure to study depressed oxygen levels in the Bay was developed based upon the volume of water that becomes dangerously low in oxygen (anoxic). The models track, over time, the total anoxic volume-days that occur throughout the Bay. The percent reductions in total annual anoxic volume-days from the 1985 reference year are then compared for various nutrient reduction scenarios.

The model was used to address a number of management issues. Several runs were designed to investigate whether nutrient reductions in any region of the Bay were more effective at improving oxygen levels than nutrient reductions in other regions. The Bay was divided into three geographic regions: upper, middle, and lower. Nutrient reduction at the limit of technology was simulated in each of these regions of the Bay to estimate resultant improvements in dissolved oxygen levels. Runs simulating 40% and 90% controllable nutrient reduction from "Bay agreement" states and runs simulating nitrogen-only and phosphorus-only controls were also examined. Based on both monitoring and modeling results, a 40% reduction target was identified as optimal in terms of reduction in anoxic-volume days for the given scenarios. Results from the 1991-92 modeling studies

are provided in Figure 3-1.

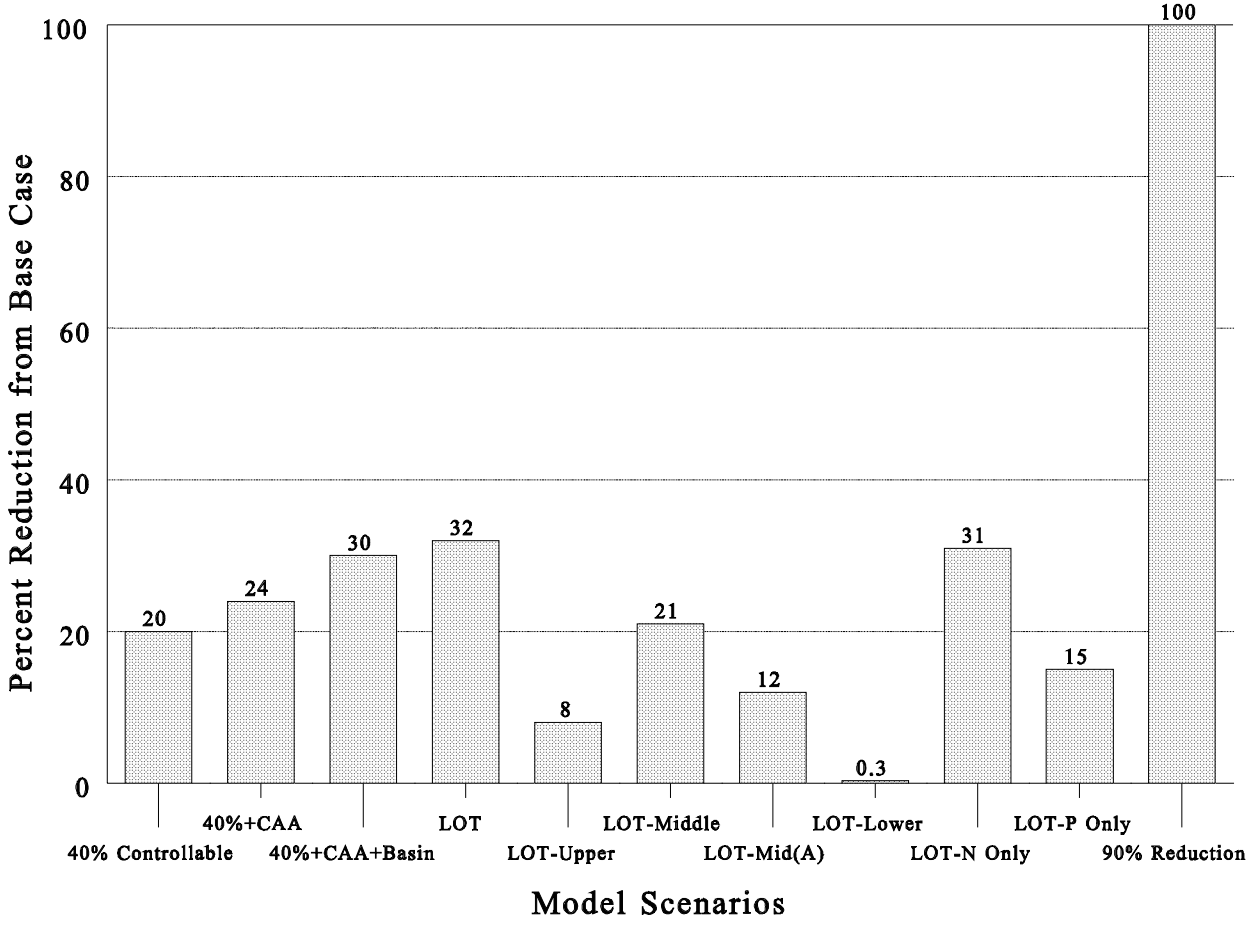


Figure 3-1. Reduction in Anoxic Volume-Days by Model Scenario

Figure 3-1 Key to Model Scenarios

(detailed explanation of scenarios in Appendix D)

40% Controllable.....40% reduction of controllable nutrients
40%+CAA.....40% Controllable plus Clean Air Act reductions
40%+CAA+Basin.....40%+CAA for entire basin (including DE, NY, WV)
LOT .....Limit of technology reductions in "Bay Agreement" states only
LOT-Upper .....LOT in upper-Bay basins, rest of basins at base loads
LOT-Middle .....LOT in Potomac & mid-Bay basins, rest of basins at base loads
LOT-Mid(A).....LOT-Middle except Potomac basin is at base loads
LOT-Lower.....LOT in lower-Bay basins, rest of basins at base loads
LOT-N Only.....LOT for nitrogen control, phosphorus at base loads
LOT-P Only.....LOT for phosphorus control, nitrogen at base loads
90% Reduction.....90% reductions of 1985 N & P levels throughout the watershed

Key findings resulting from this comparison of management scenarios were as follows:

- Nutrient reductions in the basins of the middle region of the Bay showed the largest improvements to main bay oxygen levels (20%) while those to the upper Bay showed an 8% improvement. Nutrient reductions in the lower Bay tributaries contributed little to the improvement of dissolved oxygen levels in the Bay.

- Nutrient reductions in the Potomac River basin had a significant influence on the Bay's oxygen levels and were responsible for over 40% of the reductions of the mid-Bay region's anoxic conditions. The remaining improvement of mid-Bay oxygen levels was caused by reduction of nutrients from the eastern and western coastal basins in Maryland, immediately adjacent to the Bay.

- A *40% Controllable* load reduction throughout the entire Bay watershed yielded the same 20% improvement in oxygen levels as implementing limit of technology in just the middle geographic region of the Bay.

- Trends in anoxia were tied to trends in nitrogen concentration - reduce nitrogen and oxygen levels improve. (This finding was confirmed by three scientific studies in the mid-1990's.)

In short, 40% reduction in controllable nutrients is expected to result in a 20% improvement in dissolved oxygen levels in the Bay. Such improvements not only reduce the stress on aquatic organisms, but also increase available habitat for aquatic organisms. Such habitat improvements cascade through the ecosystem. Increased availability of fish food is expected to improve the Bay's fisheries. In fact, any measurable improvement in DO should increase the number of animals that could use the Bay as nursery or feeding grounds.

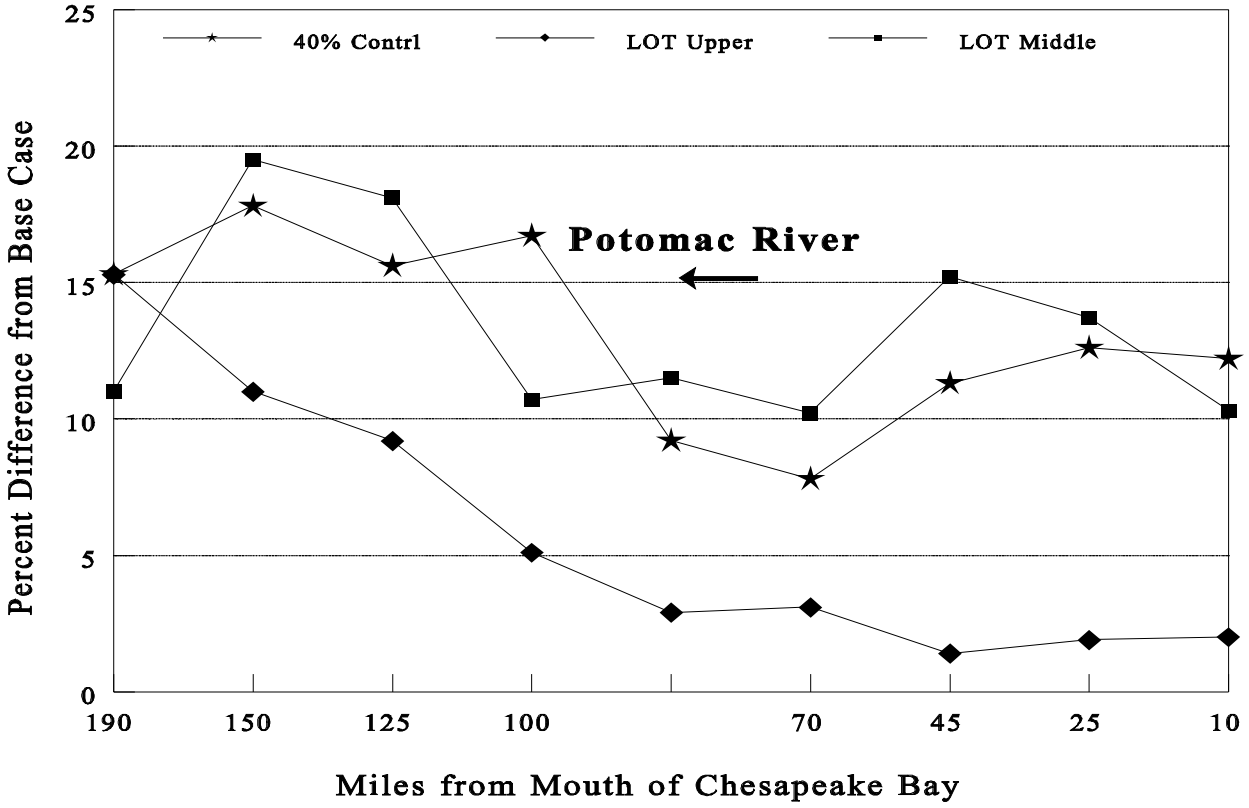
Decreased Chlorophyll Production

One of the most important habitat considerations in the Bay is the protection of submerged aquatic vegetation (SAV). The importance of this habitat can not be overemphasized, as it provides essential food and shelter for waterfowl, fish, shellfish, and invertebrates. A number of restoration targets have been established to aid the recovery of an unprecedented bay-wide decline of all SAV species since the 1950's. This decline can be attributed in large part to increasing amounts of nutrients and poor water clarity in the Bay. While nutrients such as nitrogen and phosphorus occur naturally in water and aid in SAV growth, excess amounts are considered pollutants since, as stated above, they can lead to algal blooms which rob SAV of necessary sunlight. Reducing current levels of nutrients entering the Bay would benefit SAV species and the various living resources that depend on them.

The study of chlorophyll, which is an indicator of the amount of algae in the water, is a useful tool in assessing the health of the Bay. Chlorophyll biomass acts as an indirect measure of nutrient levels and resultant phytoplankton production. Using the water quality model, it was discovered that

surface chlorophyll biomass production is limited in the upper Bay by phosphorus, while production in the middle to lower portions of the Bay is limited by nitrogen. Therefore, reduction of both nutrients is necessary to control chlorophyll biomass in the Bay as a whole. A comparison of the effect of nutrient reduction on reducing chlorophyll biomass shows that nutrient controls, especially in the Potomac (middle) region of the Bay's watershed, were very successful in controlling phytoplankton production (Figure 3-2). A 40% nutrient reduction in the Bay tributaries results in a 5-20% reduction in chlorophyll biomass of the Bay, a result that would improve light levels in and around SAV beds. This would result in increased SAV growth, a critical food and habitat resource for many species in the Bay.

Figure 3-2. Comparison of Surface Chlorophyll Biomass to Nutrient Reductions



The above figures show that the Shenandoah-Potomac Basin has a significant influence on Bay water quality, most notably dissolved oxygen and chlorophyll levels. A comparison of the nitrogen loads, by jurisdiction, in the basin is provided in Table 3-1. Based on these findings, Virginia is responsible for the reduction of eight million pounds per year followed closely by Maryland with six million pounds per year. A comparison of the reduction goals for nitrogen loads for each of the Bay's major tributaries is provided in Table 3-2.

Table 3-1. Nitrogen Loads and Reduction Goals, by Jurisdiction, in the Shenandoah-Potomac River Basin (in millions of pounds per year)

Jurisdiction	Total Controllable	40% Reduction Goal
District of Columbia	9	3
Maryland	16	6
Pennsylvania	3	1
Virginia	20	8
Basin-wide Total	**48**	**18**

Table 3-2. Reductions Goals for Nitrogen Loads to Chesapeake Bay by Major Tributary
(in millions of pounds per year)

River Basin	40% Reduction Goal
Susquehanna River	18
Maryland's Coastal Basins	17
Shenandoah, Potomac Rivers	18
Rappahannock, York & James Rivers*	19
Virginia's Coastal Basins*	Less than 2
Bay Watershed Total	**74**

*These are interim targets until enhanced computer modeling becomes available to allow final targets to be set (projected for the spring of 1997).

Although the complexity of environmental systems makes it difficult to accurately quantify the benefits of nutrient reductions, by using computer models one can describe expected environmental responses based on current scientific understanding. It is clear that reducing nutrient loads in the Bay will result in increased dissolved oxygen levels, decreased phytoplankton blooms, increased light penetration, and expanded and improved habitat for fish, shellfish, waterfowl, SAV and invertebrates. According to the model results, with a 40% reduction of nutrients, the Bay could experience a 20% reduction of anoxic volume-days (due to increased DO) and a 5-20% reduction of chlorophyll biomass (depending on location in the Bay).

The benefits of nutrient reductions are far reaching, from increased area and improved quality of SAV habitat due to increased light penetration, to increased habitat for fish and shellfish due to increased oxygen availability, to increased quality of recreational and fishing opportunities. The economic and cultural benefits that will be derived from protecting and restoring water quality in the Potomac River and the Chesapeake Bay include both measurable economic benefits to businesses that have an interest in the quality of Bay waters and less tangible benefits, such as aesthetics and quality of life, to all of the citizens of Virginia.

The Chesapeake Bay and its tributaries are a national treasure and a vital natural resource to the citizens of Virginia. Despite declines in some fish and shellfish populations, the Chesapeake Bay and its tributaries continue to support one of the most important fisheries in the nation. In 1995, dockside commercial sales of fish and shellfish were estimated to be $73.8 million. In addition, the Chesapeake Bay and its tributaries offer some of the best recreational fishing in America.

It is also important to note that many of the practices that lead to nutrient reduction provide ancillary benefits to property owners and communities. Many agricultural BMPs that are used for nutrient reduction provide benefits to farmers by retaining both topsoil and nutrients on the farm. Urban BMPs (in particular, storm water management retrofits) offer additional water quality benefits as well as mitigating storm water peak flows.

In addition to the tremendous economic benefits we derive from commercial and recreational fishing, the economic and cultural benefits of the Chesapeake Bay and its tributaries are reflected in high land values, increased tourism, and a high quality of life. While it is difficult to put a dollar figure on these benefits, it is clear that conserving and restoring the health of the Bay and its tributaries is inextricably linked to the overall economic vitality of the Commonwealth.

IV. PROGRESS TOWARD THE 40% NUTRIENT REDUCTION GOAL

This section describes the progress Virginians have made, and are expected to make, toward the 40% nutrient reduction goal in the Shenandoah-Potomac basin through ongoing activities and programs. The nutrient loads and reductions presented in the regional assessments and throughout this Strategy document are based on the best available information collected by, or provided to, the state during the assessment process and/or public review period. The 1985 base loads for each region have been recalculated based on county specific land use information and therefore differ from those presented in the August 1995 draft Potomac Basin document. In addition, any differences seen in the values used in the following sections and those found in the full regional assessment reports in the appendices of this document are due to adjustments made in response to requests of various localities and/or other interested parties since their publication in the Fall of 1996.

The Chesapeake Bay Program Computer Models

The numbers provided in the Strategy for nutrient loadings and progress toward the reduction goal are based on a combination of sources. Some loadings data are based upon direct measurements, such as discharge from wastewater treatment plants. Other data are inferred from technical studies of the effectiveness of nutrient reduction practices. Still other data are provided from computer models which are based on measured data and are used to predict loadings and water quality changes resulting from different management actions. The following two paragraphs provide a brief description of the Bay Program's computer models. Additional information on the models, and on calculations for nutrient loads and reductions, is provided in Appendices B and C.

The two models used to simulate the input of nutrients to the Bay's tidal waters and predict their impact on water quality are the Watershed Model and the Chesapeake Bay Time-Variable Water Quality (CBWQ) Model. The Watershed Model uses information on the land use coverage of the 64,000 square mile Bay drainage area to compute nitrogen and phosphorus runoff from the land. It then inputs the loads discharged by wastewater treatment plants and "delivers" the total load to the Bay. The Watershed Model relies on weather data, land use data, soil and geophysical data, and point source load estimates to calculate the total nutrient load reaching the Bay.

The Watershed Model provides input to the CBWQ Model, a time-variable simulation of the physical, biological, and chemical processes at work in the Bay. The CBWQ Model simulates responses in water quality, mainly in terms of dissolved oxygen, resulting from varying nutrient levels in the Bay. It is capable of examining future conditions under a variety of nutrient control scenarios.

Nutrient Reductions Needed to Meet the 40% Goal

The Bay Program participants established the 1985 baseline loading level as the starting point for calculating the nutrient reductions that would have to occur to reach the 40% goal. The baseline nutrient load is the sum of 1985 point source discharges and the nonpoint nutrient runoff, associated with 1985 land uses in the Shenandoah-Potomac basin, calculated for an average rainfall year.

Not all of the nutrients entering the Bay are considered controllable. Almost eleven million pounds of nutrients would naturally enter the Potomac River from Virginia each year even if the basin were completely forested. The remaining nutrients, both point and nonpoint in origin, that enter the Bay are considered "controllable" to some degree and are amenable to nutrient reduction practices. **The 1987 Bay Program commitment is to reduce the <u>controllable</u> baseline nutrient load by 40%.**

As shown in Table 4-1, the 1985 controllable baseline nitrogen load for the Virginia portion of the Shenandoah-Potomac basin is 20.428 million pounds and 40% of that is 8.171 million pounds. The baseline phosphorus load is 2.134 million pounds and 40% of that is 0.854 million pounds.

Table 4-1 1985 Nutrient Loads and 40% Reduction Goal in Virginia's Shenandoah -Potomac River Basin (Millions lbs/yr)

	Point Source	Nonpoint Source	Total	Reduction Goal
Phosphorus	0.579	1.556	2.135	0.854
Nitrogen	10.084	10.343	20.428	8.171

Ongoing Nutrient Reduction Programs and Progress Toward the 40% Goal

The Strategy effort to reach the 40% nutrient reduction goal in the Potomac-Shenandoah basin is not starting at zero. Since Virginia began working toward the 40% goal in the basin, significant reductions have been achieved through greater use of best management practices (BMPs) by farmers and foresters, enhanced nutrient removal at wastewater treatment plants, improved local storm water management and erosion and sediment control, and other initiatives. Other nutrient reductions have been achieved through locally-developed programs. Many of these programs were identified through the four regional assessment processes.

Most of these programs are described in the August 1995 draft of *Virginia's Potomac Basin Tributary Nutrient Reduction Strategy*, which was distributed to local governments, soil and water conservation districts, interest groups and numerous citizens in the basin, and to the 1996 General Assembly. An outline of these programs is provided below. Under current conditions these programs will not achieve the basin-wide 40% nutrient reduction goal by the year 2000, particularly with

respect to nitrogen loadings. However, these programs do provide an excellent foundation for further program developments or funding initiatives in the area of nutrient reductions.

Point Source Programs and Reductions

Between 1985 and 1994 the annual point source phosphorus load was reduced by 0.24 million pounds (a 41% reduction). This reduction was primarily the result of the phosphate detergent ban that went into effect in January 1988, and improved phosphorus removal at wastewater treatment facilities in Northern Virginia subject to Virginia's Potomac Embayment Standards.

During this period, point source nitrogen loads increased only 2% (0.218 million pounds per year), **despite a more than 19% increase in the amount of total wastewater flows**. The nutrient reductions that offset the increased flow volume include: the activation of biological nutrient removal (BNR) at two municipal wastewater plants, Stafford County Aquia and Dahlgren Sanitary District (although difficulties at this plant have affected the operation of BNR); closure of the Avtex facility near Front Royal; several municipal plants going off-line, with their effluent transferred to plants that provide better treatment; and the installation of a nitrification process at two large northern Virginia plants.

A number of treatment plants have installed a process known as nitrification in order to meet water quality standards for ammonia toxicity. This process is not designed to reduce the total nitrogen load in the wastewater flow, however, it converts the ammonia form of nitrogen into the less toxic, oxygenated form called nitrate. Recently, it has been determined that in certain treatment plants using this process, where the wastewater flow is below the design capacity of the plant, significant nitrogen removal is being achieved. Most importantly, nitrification is the first, and more costly, step toward achieving a full nitrogen reduction process through the installation of BNR. Where plants have installed this process, they have already realized much, or most, of the costs of BNR.

BNR is one of the most promising technologies available for nutrient reduction at municipal and industrial wastewater treatment plants. However, the ease with which this technology can be applied to a given plant varies, as determined by design parameters and the available capacity of the facility. A study is underway to assist a number of treatment plant owners in evaluating these parameters and the feasibility and cost of developing BNR technology at their facilities. This study is being conducted by Dr. Clifford Randall of VPI&SU under funding by the EPA Chesapeake Bay Program. To date, four municipal plants and two industrial plants in the Shenandoah Valley have been evaluated through this study. In addition, other related studies are underway to examine the potential for using large scale land treatment systems to process poultry wastes and municipal wastewater.

Several commentors questioned the Strategy's assertion that operating BNR could produce economic and operational benefits for wastewater treatment plants. The October 1996 draft Strategy did not repeat information on this subject that appeared in earlier strategy materials, which listed some advantages of BNR use such as: achieves nitrification (if required), with the added benefit of nitrogen

removal; reduces aeration costs and helps maintain proper pH balances in the discharge; and, increases removal of biodegradable organic substances.

Numerous reference papers, written by experts knowledgeable about BNR, have supported the beneficial aspects of BNR. They state that BNR can result in process and operating benefits relative to secondary treatment, notably reduced energy and alkalinity consumption due to the denitrification aspects of these processes, and improved process stability due to a reduced likelihood of sludge bulking. In some cases, the energy savings from reduced oxygen requirements more than offset the power usage for mixing and recycle pumping. If properly designed and operated, BNR typically improves sludge settleability and control of filamentous microorganisms. In full-scale BNR demonstrations, increased nitrification rates in the aerobic zone have been seen.

It is recognized that treatment processes can vary significantly from plant to plant, and these site-specific conditions will influence the benefits achieved through BNR operation. Therefore, the statements in the strategy regarding gains from BNR use were not intended or assumed to be applicable to all cases. However, the potential advantages of BNR systems should be considered when examining options for process improvements and nutrient removal.

Nonpoint Source Programs and Reductions

Based on available information on the implementation of best management practices (BMPs) and their known efficiencies, it is estimated that between 1985 and 1994, nonpoint source phosphorus was reduced by approximately 0.333 million pounds per year (a 21% reduction) and nonpoint source nitrogen was reduced by 2.090 million pounds per year (a 20% reduction).

The majority of these nonpoint source nutrient reductions have come from the implementation of agricultural BMPs by farmers in the Shenandoah-Potomac basin. These BMPs include a wide range of structural and operational practices. Since 1985, the implementation of BMPs and the resultant reduction in nutrient loadings have been guided by soil and water quality conservation plans (also known as farm plans) and nutrient management plans.

First and foremost, farm plans and nutrient management plans offer farmers the best technical information available on applicable conservation practices and on possible ways to improve the efficiency of their farming operations. These plans provide a comprehensive framework for farmers to evaluate the types of BMPs that will help conserve topsoil and nutrients and keep them out of the streams and rivers. In addition, these plans serve to inform the farmer as to the benefits and cost efficiencies that can be realized through the implementation of these practices. Farm plans are promoted by various federal and state agencies including USDA Natural Resources Conservation Service (NRCS), soil and water conservation districts, the Chesapeake Bay Local Assistance Department (CBLAD), and the Department of Conservation and Recreation (DCR). Approximately 55% of all cropland in the Potomac basin is covered under these plans.

Virginia's Nutrient Management Program has been expanded to reach more farmers. In particular, Nutrient Management Training and Certification Regulations have been promulgated to

govern a voluntary program for training and certifying persons preparing nutrient management plans. An important private initiative for nutrient management planning is the Virginia Poultry Federation's 1995 policy of encouraging all new growers to have a nutrient management plan and all existing growers to obtain a plan as soon as one can be written by state agencies.

Virginia's Agricultural BMP Cost-Share Program encourages the voluntary use of BMPs. The program is funded with state and federal monies through local soil and water conservation districts. Practices eligible for cost sharing include animal waste control facilities, sod waterways, stream protection, winter cover crops, buffer strip cropping, and terracing, among others. Between 1985 and 1994, over 2,685 cost-share BMPs were planned and installed on 1,637 farms in the Potomac basin. These figures do not include BMPs that have been implemented voluntarily outside of the cost-share program. A recent survey of farmers conducted by DCR showed that approximately twice as many farmers implement BMPs without cost-share funding than with cost-share funding. The estimated reductions from these BMPs, and any other practices identified locally through the assessment, have been incorporated into the figures for current and projected nonpoint source nutrient load reductions.

Current funding for cost-share BMPs in Virginia's Chesapeake Bay basin is a little over $1 million annually, of which approximately $500,000 is allocated to soil and water conservation districts in the Potomac basin. Funding is targeted to watersheds having high pollution potential as indicated in DCR's periodic *Virginia Watershed Assessment Report*.

Many other programs in the basin have led to the reduction of nonpoint source nutrient loadings. The Virginia Department of Forestry has a voluntary program which encourages the use of BMPs during timber harvesting and replanting to minimize the pollutant impacts of these activities. Statewide, use of BMPs on forest harvesting operations has increased dramatically since 1985, and this implementation may increase further as a result of the 1993 Silviculture Water Quality Bill. This legislation gives the Department of Forestry the ability to stop work and levy fines on operators or owners who are causing water quality problems through their forestry operations.

Since 1994, animal waste from confined animal operations in excess of 300 animals has been managed through a Virginia General Pollution Abatement Permit. These operations are required to meet a number of conditions that will assist in reducing nutrients from liquid animal waste. These conditions include requirements for an approved nutrient management plan and standards for waste storage and containment. The Commonwealth also regulates liquid poultry wastes and runs a litter disposal program whereby waste materials are either reused on farms or disposed of offsite in an environmentally sensitive manner.

Since 1985, Virginia and its local governments have implemented a wide array of programs designed to reduce erosion and nutrient-laden runoff from land development and urban/suburban lands. These programs include shoreline erosion control, erosion and sediment control, storm water management, Chesapeake Bay Preservation Area programs, and others. However, most of these programs serve to limit, or "cap", future increases in nutrient loadings and do not count as reductions, that is, helping to close the "gap" toward the 40% reduction goal.

Combined Point Source and Nonpoint Source Reductions to 1994

Between 1985 and 1994, the estimated annual nitrogen load has been reduced about 1.871 million pounds and the estimated annual phosphorus load has been reduced about 0.572 million pounds. This represents a 9% annual load reduction for nitrogen, and a 27% annual load reduction for phosphorus, relative to the 1985 baseline nutrient load. The gross nutrient reductions achieved between 1985 and 1994 were actually greater, but were partially offset by the nutrient-related impacts of growth and development during that nine-year period.

Table 4-2 Changes in Controllable Nitrogen and Phosphorus Loads Virginia's Shenandoah-Potomac River Basin: 1985-1994

	1985 Load - million lbs/yr			1994 Load - million lbs/yr (and % change)		
	Point Source	Nonpoint Source	Total	Point Source	Nonpoint Source	Total
Phosphorus	0.579	1.556	2.135	0.339 (-41%)	1.224 (-21%)	1.563 (-27%)
Nitrogen	10.084	10.343	20.428	10.302 (+2%)	8.255 (-20%)	18.557 (-9%)

Projected Progress Toward the 40% Nutrient Reduction Goal by Year 2000

To determine how much more nutrient reduction is needed to achieve the 40% reduction goal, it is necessary to first estimate the reductions that can be expected from continuation of ongoing state and local nutrient control programs and efforts, projected to the year 2000. To that value are added the projected increases in nutrient loadings, from point sources and nonpoint sources, that will result from population growth in the Shenandoah-Potomac basin. The total loading for each nutrient at the year 2000 can then be compared to the target nutrient load level to determine the nutrient gap that remains to be closed in order to achieve the 40% reduction goal.

Projected Point source Programs and Reductions

Point source controls currently expected to be put in place between now and 2000 are anticipated to make only modest gains towards the goal. As a result of population growth in the basin, there will be increased municipal sewage treatment flows and nutrient inputs, particularly nitro-

gen. For example, three Shenandoah basin municipal treatment plants had design capacities below 0.5 million gallons per day (MGD) in 1985 but have since expanded their plants above this threshold, and several large facilities in the Washington area are considering expansions ranging from 25% to 100% of current capacity. Expansions in industrial facilities in the Southern Shenandoah region will also increase point source nutrient loads.

It is estimated that the year 2000 point source nutrient loadings in the Shenandoah-Potomac basin, as a result of ongoing programs and anticipated growth, will represent a 10% increase in nitrogen loadings, and a 24% reduction in phosphorus loadings, relative to the 1985 baseline loads.

Projected Nonpoint Source Programs and Reductions

It is estimated that the year 2000 nonpoint source nutrient loads in the basin, as a result of progress achieved through current and anticipated best management programs, will be reduced 28% for nitrogen and 30% for phosphorus. These projections are based on anticipated BMP implementation through a number of existing programs, including the Virginia Agricultural BMP Cost-Share Program, the Virginia Nutrient Management Program, the Chesapeake Bay Preservation Act, the Food Security Act of 1985, the installation of BMPs on all forestry harvests, and reductions that will result from voluntary implementation of agricultural BMPs and other nutrient reduction practices.

Combined Point Source and Nonpoint Source Reductions Projected to Year 2000

The population of Virginia's Shenandoah-Potomac River basin is expected to grow by nearly 17% between 1990 and the year 2000, leading to increased nutrient loads that will partially offset the reductions that will be achieved. Projecting nutrient reductions and increases to the year 2000, it is estimated that annual nutrient loadings will have been reduced by 2.311 million pounds for nitrogen and 0.601 million pounds for phosphorus. This represents a 11% annual loading reduction for nitrogen and a 28% reduction for phosphorus, compared to the full 40% nutrient reduction goal (see Table 4-3).

Table 4-3. Projected Year 2000 Nutrient Loads and Reduction Gap in Virginia's Shenandoah-Potomac River Basin (Million lbs/yr and % Change)

	Point Source	Nonpoint Source	Total Year 2000 Loading (and % change)	Nutrient Reduction Gap
Phosphorus	0.436	1.097	1.534 (-28%)	0.253 (12%)

Nitrogen	10.616	7.502	18.117 (-11%)	5.861 (29%)

Closing the Gap, Maintaining the Cap

The difference between the 40% goal and the actual reductions in Virginia's Shenandoah-Potomac basin yields an annual "nutrient loading gap," that will need to be closed, of 5.861 million pounds for nitrogen (29% yet to be achieved, compared to the full 40% goal) and 0.253 million pounds of phosphorus (12% yet to be achieved). Closing this gap is the task of Virginia's Shenandoah and Potomac River Basins Tributary Nutrient Reduction Strategy.

Once the 40% nutrient reduction goal is achieved, it will be important to maintain the annual "nutrient cap" while still accommodating growth and development in the Potomac basin. The cap represents the annual amount of nutrients entering the Potomac River once the 40% reduction target is met. This annual loading amount must not be exceeded in order to sustain the improvements in water quality that are realized through closing the gap. Thus, as growth occurs, programs must be in place that ensure that nutrient loads do not increase beyond the cap level.

Understanding the difference between programs that help to close the gap toward the 40% nutrient reduction goal and programs that will help to maintain the nutrient cap is important. Many local government programs are designed to limit nonpoint source pollution, including nutrients, that would otherwise result from development or other changes in land use. These local government programs must be categorized as cap-maintenance programs because they do not reduce nutrient loadings compared to the 1985 baseline level, and therefore they cannot be credited toward the 40% reduction goal. However, these programs are no less important than gap-closing programs because both serve the valuable purpose of limiting the total nutrient load that enters the Potomac River and the Chesapeake Bay.

V. PROCESS FOR DEVELOPING THE POTOMAC STRATEGY

Beginning the Strategy Process: Previous Publications, and Guidance from Virginia Citizens

In August of 1993, Virginia produced a discussion paper, *Reducing Nutrients in Virginia's Tidal Tributaries: the Potomac Basin*, that explained the need for nutrient reductions and characterized the land use, water quality and living resources in the Shenandoah-Potomac basin. The paper discussed opportunities for nutrient reduction, focusing primarily on those that are most cost-effective (i.e., lowest cost per pound of nutrient reduced), particularly agricultural BMPs.

Many citizens, including the agricultural community, who provided comments on that discussion paper stated their viewpoint that the Strategy should plan a more equitable distribution of responsibility for nutrient reductions in the basin, even if that would lead to a higher total cost. A more equitable approach was included in Virginia's second Potomac Strategy paper, published in October 1994, entitled *Actions and Options for Virginia's Potomac Basin Tributary Nutrient Reduction Strategy*.

In October 1994, six public meetings were held in the Shenandoah-Potomac basin to provide further information to citizens on the need for nutrient reductions and to hear their viewpoints and responses. During March and April of 1995, Virginia's Secretary of Natural Resources met with local government officials, soil and water conservation districts, and local interest groups across the basin to solicit their participation. During those meetings, many citizens stated that the best way to achieve the administration's goals of cost-effectiveness, practicality and equity would be to include citizens, interest groups and stakeholders at the local level in the fundamental decision making and development of the Shenandoah-Potomac Strategy.

This very important guidance from citizens in the basin was incorporated into the publication, *Draft Virginia Potomac Basin Tributary Nutrient Reduction Strategy*, in August of 1995. The highlights of that document were:

- Promoted an approach centered on local initiatives.
- Contained detailed information on existing local nutrient reduction programs.
- Outlined the types of practices that can be implemented for further nutrient reductions.
- Described the significant nutrient reductions that have been achieved since 1985 and the programs that were responsible for these reductions.
- Using projections to the year 2000, it described how further progress will be achieved through ongoing programs and estimated the "nutrient gap" that will need to be closed.
- Suggested a regional breakdown of the basin to help facilitate the development and implementation of local strategies.
- Described ongoing programs offered by the Commonwealth to facilitate continued success.
- Provided a preliminary menu of funding options for financing nutrient reductions.

The 1995 draft strategy was sent to every local government and soil and water conservation district in the Shenandoah-Potomac basin, all General Assembly members, agricultural interests, environmental groups and other interested citizens for review and comment. A series of six public meetings were held during September and October 1995 to receive additional comment. Based on the responses to the draft strategy, which included concerns over public education, financing, and the need for local officials to have a rational basis for promoting additional nutrient reductions, it was concluded that local officials and other stakeholders needed to be even more closely involved as partners in the design of a final strategy.

Therefore, early this year the Secretary of Natural Resources sent letters to the chief elected local government officials throughout the basin, inviting them to become personally involved in an assessment process designed to increase the degree of state/local/citizen partnership in the development of the Strategy. It reaffirmed that the Governor and the Secretary are committed to working closely with local elected officials and concerned citizens to determine how best to achieve the nutrient reduction goals for the Chesapeake Bay.

General Assembly Actions in 1996

Two actions by the General Assembly in 1996 related directly to the Potomac Strategy. The first, House Bill 1411, set forth deadlines and certain content requirements for the tributary strategies that were under development by the state. The second was an appropriation of $280,000 to soil and water conservation districts in the Chesapeake Bay watershed for the purpose of promoting tributary strategy development. This money is administered by the Department of Conservation and Recreation and is being allocated on a competitive basis within the tributary basins of the watershed.

The Assessment Process

At the core of the Strategy are the results of the assessments that were conducted in four regions of the Shenandoah-Potomac basin from March through September of 1996. The purposes of the assessments were to confirm progress to date, quantify local nutrient reduction programs and to identify additional actions appropriate for each region to close the gap and achieve the 40% reduction goal. The participants included representatives of local governments, soil and water conservation districts, wastewater service authorities, planning district commissions, conservation groups, farmers and other citizens in order to link the development of the Strategy as closely as possible to the interests and concerns of regional stakeholders, who are the eventual implementors of the Strategy.

This process was facilitated by subdividing the basin area into four regions, Southern Shenandoah, Northern Shenandoah, Northern Virginia, and Lower Potomac (see map, page 5). The baseline nutrient loadings were determined for each county in each region, as well as the 40% reduction targets for each of those jurisdictions.

State technical assistance teams were assigned to each region. These teams included agency

staff from the Departments of Environmental Quality, Conservation and Recreation, and Chesapeake Bay Local Assistance and from the Cooperative Extension Service. These teams were made up of staff who have expertise in the areas of storm water management, erosion and sediment control, land use planning and development, agricultural BMPs, nutrient management, point source management, and education.

In certain regions, staff of regional planning district commissions and/or soil and water conservation districts played significant roles in assisting or guiding the assessment process. These tributary teams facilitated the development of regional strategies and encouraged close working relationships among local officials and other interested parties.

In each region, the assessment process was initiated by a letter from Virginia's Secretary of Natural Resources to the chief elected official of each county, city and town in the region and the chairperson of the applicable soil and water conservation district(s). The Secretary asked these officials to become directly involved in the assessment process, to ensure that it would be guided by local perspectives and benefits, and to attend an initial meeting describing the need for nutrient reductions and the goals and process of the assessment.

At these initial meetings, presentations were provided by the state technical assistance teams on the Shenandoah-Potomac Strategy effort. The four initial regional meetings were attended by 180 local officials, including members of boards of supervisors, city councils, town councils and soil and water conservation districts, as well as representatives from wastewater utilities, planning district commissions, conservation groups and others. Local government officials were asked to consult, and ultimately represent, the businesses, industries, farmers and other citizens in their jurisdiction and to help identify practical and cost-effective nutrient reduction measures. They were not asked to commit to implementing or funding the identified measures.

Three to five full meetings were held in each region, and General Assembly members were invited to attend meetings affecting their district. In addition, meetings were held with smaller groups on particular issues as the need arose. The state technical assistance teams were available at these meetings, and various information documents were produced and distributed. The specific elements of the assessment process varied among regions, as determined by the local participants. However, these processes were based on consistent approaches and the same objective, and the resulting assessments were compatible. Each region was provided with a county-by-county breakdown of:

- nonpoint source and point source nutrient loads estimated for 1985 and 1994 and projected to the year 2000;
- acreage, and changes in acreage, of agricultural land use;
- types and acreages, or numbers, of existing BMPs;
- land use changes and increased treatment plant loadings due to population growth;
- nutrient reductions estimated for 1994 and projected to the year 2000; and
- estimated costs per pound of nutrient reduced for the range of nonpoint source and point source reduction opportunities available in the jurisdiction (planning-level costs and expected reductions for point source upgrades were specific to the individual treatment plants).

The participants in each regional assessment took those numbers and consulted with agricultural representatives, wastewater treatment plant operators and others in their jurisdictions to determine the best mix of practices that could be used to meet the nutrient reduction target, either on a local or regional basis. This decision making included estimates of the types and amounts of agricultural nonpoint source control practices that would likely be implemented in each jurisdiction, and, if necessary, what conditions would need to be met, such as the availability of increased cost-share funding.

During the assessment process, the participants were told that their local assessments could be conditioned on any reasonable incentive including the availability of additional cost-share funding. And in every assessment, the participating local governments, farmers and others proposed that cost-share money be made available for the implementation of these practices. Very few participants volunteered to undertake nutrient reductions in the absence of some action on funding being taken by the state. However, certain localities made substantial local commitments to nutrient reductions, in partnership with the state, that would be implemented concurrently with increased cost-share funding for nonpoint source control practices, including necessary planning and design.

The final assessments tallied the mix of practices, chosen locally or regionally, and the costs associated with implementation of these practices. These assessments are summarized in Section VI and are detailed in Appendices H through K.

Defining the Options for Meeting the Costs, and Gathering Citizen Input

Within the general context of a cost-sharing approach to funding the Strategy, specific decisions must be made regarding funding sources. These decisions include assigning funding responsibilities to various portions, or all, of the population, and determining programmatic mechanisms for acquiring these funds.

To identify and review the range of funding options that could be available for funding nutrient reductions, the Department of Agricultural and Applied Economics at VPI&SU produced a report entitled *Financing Virginia's Tributary Strategies: Methods for Meeting the Costs of Nutrient Reduction* (August 15, 1996). This report provides information on different approaches to sharing the costs for nutrient reductions. It also provides information on various funding programs that can be implemented at the state or local level, and evaluates these programs with regard to their revenue generating potential, ease and cost of administration, reliability of revenue stream and incentive effects.

In an effort to ensure a broad spectrum of input into the financing issue, and to continue the localized approach to Strategy development, this financing report was sent to each of the participants in the regional assessment process, followed by meetings held to collect their comments. In addition, consultation meetings were held with various stakeholder groups, as required under House Bill 1411 in order to garner their input and response. The results of this input are presented in Section VII, Meeting the Costs of Nutrient Reduction.

Public Review of the Final Comment Draft Document

During the public comment period, an executive summary of the draft document was available on the Internet at the Department of Environmental Quality website (http://www.deq.state.va.us/envprog/potomac.html), at the Department of Conservation and Recreation website (http://www.state.va.us/~dcr/tempsite/tribstra.htm) and at the Chesapeake Bay Local Assistance Department website (http://www.state.va.us/cblad/homepg.htm). These websites contain directions on how to access and download the entire draft document. Public review copies of the draft document were distributed to regional state depository libraries, soil and water conservation district offices, planning district commissions and regional offices of DEQ and DCR in the Shenandoah and Potomac River basins. Personal review copies were sent to:

- all members of city and town councils and the county boards of supervisors in Virginia's Shenandoah-Potomac basin;
- all directors of soil and water conservation districts in the basin; and
- mayors and chairmen of the city and town councils and the boards of supervisors in the rest of Virginia's Chesapeake Bay watershed.

Because of the legislative requirements to produce a Shenandoah-Potomac Strategy by January 1, 1997, the time available for final modifications to the Strategy after the public review and comment period was extremely limited. Consequently, all comments on this draft document must have been received by the close of business on December 2, 1996. However, the development and implementation of the Strategy is an ongoing process, and state agencies will continue to make every effort to work with local officials and others to refine the Strategy and develop consensus on its key elements.

Written comments were received from seven local governments (three from Northern Virginia, three from the Shenandoah Valley, and one from outside of the Shenandoah-Potomac basin), one regional agency, four service authorities, one service authority agency, one soil and water conservation district, three business/industry groups, four conservation groups, eleven other basin citizens including farmers, one Chesapeake Bay Program Committee, one federal agency (three commentors from EPA) and two academic institutions.

In these comments, there were few direct criticisms of the 40% reduction goal, yet several commentors wanted to see the benefits of achieving this goal more clearly defined in the final Strategy. Virginia's approach to working with local governments and stakeholders received general praise, although a number of citizens stated that the voluntary approach should be backed up by ways to ensure that all nutrient sources participate in achieving reductions, and still others questioned whether a strictly voluntary program would work. The Strategy's point source hierarchy is intended to address such concerns within the context of cost-shared point source nutrient reductions.

Many technical issues were raised by commentors, particularly local governments and agencies who questioned the efficiencies and costs of biological nutrient removal (BNR) and urban best

management practices/storm water management retrofits. These issues, along with the general issue of technical uncertainty, are acknowledged and addressed in Sections IV and VI.B and throughout the document. In response to the statements of numerous commentors that testing, tracking and stream monitoring is needed, the Strategy more clearly details the ongoing efforts to monitor and track water quality in the basin. These tracking programs include monitoring chemical and biological indicators in both the mainstem of the Bay and the Shenandoah and Potomac River basins.

Although the cooperative, regional assessment *process* was not criticized, there was both agreement and disagreement with the *products* of the regional assessments. Some commentors in the agricultural community were opposed to the emphasis on agricultural nonpoint source control practices, and others stated that industrial sources and small municipal treatment plants should be addressed in the Strategy. There was also concern that the total of the four assessments did not achieve the 40% goal, and how the responsibility for closing the remaining nutrient gap would be allocated. This issue was reexamined and addressed in Section VI.B.

Looking beyond the gap-closing issues, numerous commentors expressed concern about the cap on nutrient loading once the reduction goal is achieved. In addition to general statements made by local governments, service authorities and the EPA as to the importance of addressing the cap issue, local governments and sewer authorities in the Shenandoah Valley felt that nutrient control upgrades in their region should be reserved to address future cap needs rather than used for basin-wide gap closing. The nutrient cap is clearly an important issue, but was not sufficiently addressed due to the Strategy deadline. The Strategy is not a one-time effort, but rather an ongoing, dynamic document to be used as a tool in coordination with local governments over time to identify the best possible approach to maintaining the nutrient cap. Refinements and updates to the Strategy will be documented, as needed, in the Annual Report on Virginia's Tributary Strategy Program, which is submitted to the General Assembly by November 1 of each year in accordance with State law.

There were many comments regarding implementation and funding. Some commentors wanted state cost-share funding as a prerequisite to implementation, whereas others stated that the Strategy should be implemented regardless of funding availability. In addition, there was concern as to how nutrient reduction practices would implemented, maintained and monitored in cases where public funds were appropriated. The implementation of the Strategy as described in this document remains much the same as in the October 1996 draft, while the administration's funding proposal provides a more clearly defined funding approach. There were also commentors who stated that nutrient trading was an implementation/funding option that should be explored more thoroughly. This will become more of an issue as the nutrient reduction goal is achieved and cap maintenance moves to the forefront.

Review and Action by the General Assembly

This final version of the Shenandoah-Potomac Strategy was completed and distributed on January 1, 1997. It is expected that the Strategy will be reviewed by the General Assembly during the 1997 legislative session.

The matter of financing nutrient reductions is the central issue in deliberations on the

Strategy. Numerous other issues are closely related to these discussions on financing. Many of these issues are addressed in this Strategy plan; others are relevant to the authority and actions of the General Assembly. They include:

- the need to equitably apportion funding responsibility;
- the effective design, authorization and administration of funding and implementation programs at the state and local levels;
- the relationship of these programs to existing programs and regulations;
- whether it is necessary to prioritize practices and phase implementation;
- the challenges and benefits of establishing a market-based system (nutrient trading); and
- the relationship between the provision of funding for the Shenandoah-Potomac Strategy and the future success of other tributary strategies.

Continuation of the Strategy Process

Virginia's Shenandoah-Potomac Strategy is built upon a new, cooperative approach to water quality improvement and protection. This approach is one that can only truly be effective through the development of long-term partnerships and continued coordination. Therefore, the Commonwealth is committed to working in partnership with communities and the private sector toward the implementation of the Strategy in the basin. Citizen initiatives and voluntary efforts will continue to be promoted, and methods will continue to be sought that encourage individual stewardship outside of the need for regulation. In addition, continued efforts will be made to provide information to citizens on their role in reducing nutrient loads, and to better educate them on how they can contribute to improving water quality in their local streams and rivers and the Chesapeake Bay.

To the extent that specific programs are funded or developed as a result of General Assembly action the Strategy, Virginia's state agencies will work with citizens and communities to ensure fair, effective and equitable implementation of these programs. State agencies will work to efficiently integrate any new elements into the existing framework of programs that are currently administered.

Following action by the General Assembly, the Commonwealth's natural resources agencies will evaluate the status and scheduling of Strategy actions, outstanding issues of implementation and the need for any alternative measures. This will be done on an ongoing basis in coordination with local representatives and will be described in the future annual reports submitted to the General Assembly under the requirements of House Bill 1411. This approach is further discussed in Section VI. B.

VI. STRATEGY ACTIONS TO MEET THE 40% NUTRIENT REDUCTION GOAL

This section catalogs the types and costs of nutrient controls that were identified for meeting the 40% reduction goal and is primarily the product of the four regional assessments. However, the sum of the estimated nutrient reductions that would be achieved through implementing the regional assessments still leaves Virginia short of the 40% goal. Therefore, in order to meet the goal, additional options for nutrient reduction are offered at the end of this section.

Summary of Regional Nutrient Loadings and Reduction Targets

As depicted in Section IV, upon implementation of current nutrient reduction programs and with projected growth in the Shenandoah-Potomac basin, there will still be a nutrient reduction gap of 12% (0.253 million pounds) of phosphorus and 29% (5.861 million pounds) of nitrogen at year 2000. Table 6-1 presents the basin-wide estimates for nutrient loadings and projections broken down for each region. This information was the starting point for the regional assessment process.

Table 6-1. Total Nutrient Loads for Virginia's Shenandoah-Potomac Basin
Based on Implementation of Current & Planned State Programs

Year 1994 Progress to Date

	1985 Controllable Loads (thousands of lbs)		Year 1994 Reported Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Southern Shenandoah	4,083	942	3,082	-25%	639	-32%
Northern Shenandoah	2,742	419	2,084	-24%	318	-24%
Northern Virginia	12,505	658	12,563	0%	543	-17%
Lower Potomac	1,098	115	828	-25%	62	-46%
VA Potomac Basin	20,428	2,135	18,557	-9%	1,563	-27%

Year 2000 Projections

	1985 Controllable Loads (thousands of lbs)		Year 2000 Estimated Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Southern Shenandoah	4,083	942	2,796	-32%	641	-32%
Northern Shenandoah	2,742	419	2,088	-24%	313	-25%
Northern Virginia	12,505	658	12,475	-0%	535	-19%
Lower Potomac	1,098	115	758	-31%	46	-60%
VA Potomac Basin	20,428	2,135	18,117	-11%	1,534	-28%

A. Results of Virginia's Shenandoah-Potomac Strategy Assessment Process

Locally-Based Process

The purpose of the regional assessment was to identify practical, cost-effective and equitable

solutions to reduce nutrient loads through a bottom-up process that included local officials, soil and water conservation districts, treatment plant operators, farmers and other interest groups. The main question to be answered was: "Which practices would be best for reducing nutrient loads in your region, and what conditions would lead to the implementation of these practices?"

Summaries and results of the four assessments are provided below. (Note: in the summaries that follow, the assessment products are termed "regional assessments" or "regional strategies", interchangeably). These summaries include an overview of regional issues and nutrient sources, lists of participants, the types and costs of recommended nutrient reduction practices, and certain recommendations for implementation, such as expanded cost-share funding and technical assistance. The four regional assessments are presented, in their entirety, in Appendices H through K.

Common Elements Among the Regional Assessment Processes

As discussed in Section V, the regional assessments followed a consistent format, guided by the state technical assistance teams. In addition, a number of common viewpoints were expressed by a majority of the participants. These are briefly discussed below as an introduction to the summaries of the individual regional assessments.

No Unfunded Mandates

The most consistently voiced opinion by local officials, farmers and others who participated in the assessment process was that they did not support unfunded mandates. The major factor determining their participation in the voluntary assessment process was an agreement that the Strategy would not turn into an unfunded mandate.

Cost Effectiveness and Equity

Cost effectiveness means achieving the highest nutrient reduction per dollar spent. Equity refers to sharing responsibility for nutrient reductions. Participants in the Strategy process expressed the need for a balance between equity and cost effectiveness.

The determination of which practices would be recommended through the assessment was primarily based on cost effectiveness, rather than equity. However, participants wanted to be assured that their neighboring regions, with varying types of nutrient sources, were equitably participating in the process, regardless of who could achieve nutrient reductions less expensively. Equity was also the guiding principle in deliberations on how the costs for these practices should be borne.

Monitoring, Modeling and Related Technical Issues

The basic tools of the regional assessments were numerical goals, nutrient loading rates, reduction efficiencies and costs. All of these numbers are, to a degree, based on estimates or projections, such as acreage of land uses, crop types and management practices, and projected changes in these figures; estimates of point source loadings and projected population increases; and

projections of costs and nutrient reductions for the implementation of various practices.

These estimates are based on state-of-the-art research and computer modeling, and one of the best water quality monitoring networks in the nation. However, in each region, concerns were raised regarding the comprehensiveness of the data and the accuracy of estimates. Some of these concerns were alleviated after further information and explanations were provided regarding the development of the data and modeling efforts. In response to the October 1996 draft Strategy, several commentors stated that the Strategy needed more emphasis on testing, tracking, and stream monitoring. It is agreed that one of the best ways to judge progress under the strategy is though programs that monitor nutrients and dissolved oxygen concentrations in the water, and examine other indicators such a underwater grasses and living resources.

The Federal-Interstate Chesapeake Bay Program has had an extensive and comprehensive monitoring program in place since 1984. Components of this program address water quality and other physiochemical parameters, as well as biological measures and living resources. They indicate conditions in the mainstem Bay, the tidal tributaries, at the fall line, and in the nontidal rivers and streams. They gauge stream flow and groundwater contributions, as well as improve our estimates of nonpoint source inputs and point source discharges. These programs will continue throughout strategy implementation and will be heavily relied upon to evaluate progress made towards the nutrient reduction and Bay restoration goal.

Regarding the Potomac, one specific enhancement to the monitoring network is the addition this year of two stations in the Shenandoah basin (near Strasburg and Front Royal) to further document nutrient loads and allow trend analysis during Strategy implementation. The protocol used at the fall line stations will be in place at these stations, with storm event and base-flow water quality samples collected and analyzed for suspended solids and nutrients (nitrogen and phosphorus, for totals as well as species and dissolved fractions).

There is also an ongoing effort to enhance the interaction between state agencies and citizen conservation groups that perform monitoring. As noted in the August 1995 draft Strategy, there are many river stewardship groups that conduct environmental monitoring in their areas, including the Fairfax Audubon Society, Friends of the Shenandoah, Friends of the North Fork Shenandoah, Friends of Mason Neck, Friends of Dyke Marsh, Friends of Sugarland Run, North Fork Goose Creek Watershed Project, and Opequon Watershed. The Strategy provides an opportunity for citizen conservation groups, local businesses and corporations, local government and planning commissions, and state agencies to improve cooperation and fully utilize data collected by these groups to identify and correct pollution problems.

1. Southern Shenandoah Regional Assessment

Regional Description

The Southern Shenandoah region is approximately one-third of the area of Virginia's Shenandoah-Potomac basin and includes all of Rockingham and Page Counties, portions of Augusta

and Highland Counties, and the cities of Harrisonburg, Staunton and Waynesboro. Nearly all of the South Fork Shenandoah River, including its major tributaries the North, Middle and South Rivers, is in this region. Based on 1994 data, agriculture and forest are the major land uses, with 59% forested and 37% in cropland and pasture. Less than 4% of the region is urban or suburban. Ten significant (greater than 0.5 M.D.) point source dischargers are located in the region, including seven municipal wastewater treatment plants and three industries.

Summary of Nutrient Loadings and Reduction Targets

In 1985, this region contributed 20% (4.083 million lbs) of the basin's controllable nitrogen load, and 44% (0.942 million lbs) of the controllable phosphorus load. In 1985, 77% of the region's controllable nitrogen and 65% of controllable phosphorus came from nonpoint sources. Table 6-2 provides regional loadings for 1985, 1994 and projected to the year 2000.

Table 6-2. Total Nutrient Loads for Southern Shenandoah Region
Based on Implementation of Current & Planned State Programs

Under current programs, by the year 2000 the region is expected to achieve a 1.286 million pound reduction in annual nitrogen loadings (32% reduction for the region) and a 0.301 million pound reduction in annual phosphorus loadings (32% reduction). For nitrogen, this leaves a 0.347 million pound gap in reaching the 40% reduction goal. For phosphorus, this leaves a 0.075 million pound gap in reaching the 40% goal.

Overview of the Southern Shenandoah Regional Assessment Process

The Southern Shenandoah assessment included five regional meetings, with representation from the four counties, three cities, and a number of the towns in the region; Headwaters, Mountain and Shenandoah Valley Soil and Water Conservation Districts(SWCDs); the Poultry Federation; the Farm Bureau; several environmental groups; and a number of the municipal and industrial wastewater treatment plants in the region. In addition to the regional meetings, the Central Shenandoah Planning District Commission (PDC) coordinated numerous meetings with local technical staff as part of the strategy development. The role of the Central Shenandoah PDC was critical to developing the regional proposal.

From the outset, the decision was made to develop a *regional* strategy that achieved the

Year 1994 Progress to Date

	1985 Controllable Loads (thousands of lbs)		Year 1994 Reported Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Augusta County	1,765	416	1,245	-29%	256	-38%
Highland County	56	9	46	-19%	9	-5%
Page County	393	86	293	-26%	68	-21%
Rockingham County	1,868	431	1,499	-20%	307	-29%
Southern Shenandoah	4,083	942	3,082	-25%	639	-32%

Year 2000 Projections

	1985 Controllable Loads (thousands of lbs)		Year 2000 Estimated Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Augusta County	1,765	416	1,160	-34%	242	-42%
Highland County	56	9	41	-26%	9	-6%
Page County	393	86	257	-35%	62	-29%
Rockingham County	1,868	431	1,338	-28%	328	-24%

reduction goal, as opposed to individual county and city strategies that each achieved a 40% reduction. The first step taken in the assessment process was to make sure that all local activities were being counted in the nutrient reduction progress calculations. As the proposal was developed, cost-effectiveness was the key factor in determining which additional actions to recommend. The end result of the assessment process was the development of the Southern Shenandoah Region - Potomac Tributary Strategy which is included in Appendix H. Endorsement of the strategy document has been received from the Augusta County, Rockingham County, Page County and Highland County Boards of Supervisors; the Harrisonburg and Staunton City Councils; the Bridgewater Town Council; the Shenandoah Valley and Headwaters SWCDs; and the Central Shenandoah PDC.

Summary of Southern Shenandoah Region Assessment Recommendations

The following recommended actions are the result of the assessment in the Southern Shenandoah region. They rely primarily on additional agricultural measures implemented through the state's cost-share program as the most cost-effective means of achieving the goal.

1) Nutrient Management Plans (NMPs) would be required by local ordinance on all intensive agricultural operations.
2) Additional state staff would be provided to write NMPs.
3) Increased cost-share funding for best management practices (BMPs) would be provided to the soil and water conservation districts (SWCDs).
4) Additional staff would be provided to the three SWCDs to oversee increased BMP activity. It is anticipated that the major additional activities would be in the areas of stream fencing, grazing land protection, stream protection, and animal waste control facilities such as poultry litter sheds, dairy pits and loafing lot systems.
5) Seventy-five percent (75%) cost-share funding would be offered on all animal waste control facilities and removing the cost-share funding cap on these practices. The impact would be greatest on dairy pits, which cost an average of $100,000 each. Additional cost-share funding would need to be provided to cover this cost without drawing resources from other practices.
6) Biological nutrient removal (BNR) technology would be installed at one basin of Harrisonburg/Rockingham Regional Service Authority's North River treatment plant.
7) Voluntary monitoring for total nitrogen and phosphorus concentrations should be undertaken at all treatment plants in the basin with flows of 0.5 M.D. or discharging the equivalent nutrient load.
8) The state needs to continue to improve its efforts to verify the loadings from the Southern Shenandoah region; monitoring data and modeling information should be distributed more widely.
9) Grant funding for BNR should be included for future treatment facility upgrades and expansions. Several facilities in the Southern Shenandoah region that currently discharge at low nitrogen concentrations might require BNR upgrades to maintain those low concentrations as they increase their flow volume with growth.

Nutrient Loadings Under Proposed Southern Shenandoah Assessment

Table 6-3 includes a summary of the proposed regional increases in BMP implementation for each type of practice and the associated nitrogen and phosphorus reductions. The result of these recommended actions is a 50% reduction in the region's nonpoint source nitrogen loading and a 44% reduction in nonpoint source phosphorus loading. The principle reductions are obtained through increased nutrient management and the associated construction of animal waste control facilities. The plan also includes a substantial amount of stream fencing which, in addition to a nutrient reduction benefit, has a substantial impact on the biological integrity of local waters.

Overall nutrient reductions through the implementation of the proposed Southern Shenandoah regional strategy would be 43% for nitrogen and 40% for phosphorus. The nutrient reductions that would be achieved for each local jurisdiction under the proposed strategy are detailed in Tables 6-4 through 6-6.

Cost of the Proposed Southern Shenandoah Strategy

The total estimated cost of the proposed strategy for the Southern Shenandoah region is $6.7 million. The strategy assumes that outside funding would be made available for BMP implementation. The cost also includes additional technical staff that would be required under an expanded BMP implementation program. The costs are only those needed to reach the 40% reduction goal and do not include future costs of maintaining or replacing the proposed implementation practices as they complete their expected life span. For example, nutrient management plans typically require updating every three years. An itemized cost estimate for the proposed Southern Shenandoah Strategy is included in Appendix H.

Table 6-3. Nonpoint Source Nutrient Reductions for Southern Shenandoah Region

Based on Implementation of Proposed Regional Assessment

		Total Proposed Coverage		Reductions (lbs/year)		Increased Ac	Added Reductions Ach'd	
BMP Treatment	units	Coverage	Percent	Nitrogen	Phosphorus	of Coverage	Nitrogen	Phosphorus
Conservation Tillage	acres	54,599	67.4%	5,529	690	0	0	0
Farm Plans	acres	125,071	55.4%	77,452	26,294	2,558	1,478	528
Nutrient Management	acres	256,776	83.4%	730,289	117,048	155,164	349,688	55,542
Highly Erodible Land Retirement	acres	6,759	1.4%	49,567	12,058	0	0	0
Grazing Land Protection	acres	10,852	4.3%	27,092	2,139	2,771	6,943	599
Stream Fencing	linear feet	387,641	-----	12,301	3,648	112,200	3,597	1,056
Stream Protection	linear feet	32,000	-----	11,235	4,932	8,400	2,803	1,283
Cover Crops	acres	37,384	-----	142,054	12,960	0	0	0
Grass Filter Strips	acres	188	-----	1,584	214	0	0	0
Woodland Buffer Filter Area	acres	36	-----	574	100	0	0	0
Forest Harvesting	acres	7,606	100.0%	96,229	3,311	0	0	0
Animal Waste Control Facilities	systems	975	-----	445,465	99,751	76	49,638	11,069
Loafing Lot Management	systems	59	-----	9,348	2,058	6	911	210
Erosion & Sediment Control	acres	805	100.0%	7,592	4,410	0	0	0
Urban SWM/BMP Retrofits	acres	0	0.0%	0	0	0	0	0
Urban Nutrient Management	acres	573	10.0%	625	65	0	0	0
Septic Pumping	systems	0	-----	0	0	0	0	0
Shoreline Erosion Protection	linear feet	0	-----	0	0	0	0	0
Total Pounds Reduced:				1,616,936	289,676		415,059	70,286
Adjustment for Land Use Changes:				11,973	8,229			
Adjustment for Poultry Growth:				47,630	10,681			
Adjusted Reduction:				1,557,332	270,766			
Nonpoint Controllable Amount:				3,127,339	616,657			
Percent Reduction:				49.80%	43.91%			

Table 6-4. Point Source Nutrient Loads Southern Shenandoah Region

(in thousand of pounds per year)

		1985 Nutrient Loads		1994 Loads & Percent Change				Regional Strategy Loads & Percent Change			
Facility	Location	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change	Nitrogen	% Change	Phosphorus	% Change
Fishersville	Augusta	31	12	21	-31%	7	-45%	27	-12%	9	-30%
Middle River	Augusta	0	0	30	-70%	9	-78%	88	-21%	19	-58%
Stuarts Draft	Augusta	20	8	10	-48%	2	-69%	16	-18%	4	-48%
Verona	Augusta	11	4	37	236%	6	31%	0	-100%	0	-100%
Staunton	Staunton	101	41	0	-100%	0	-100%	0	-100%	0	-100%
Dupont	Waynesboro	207	46	65	-68%	4	-91%	74	-64%	5	-90%
Waynesboro	Waynesboro	132	39	145	10%	23	-42%	145	10%	23	-42%
Luray	Page	29	12	5	-84%	5	-59%	17	-42%	8	-32%
North River	Rockingham	253	102	305	20%	49	-52%	298	18%	50	-51%
Merck	Rockingham	161	49	185	15%	54	9%	105	-35%	85	73%
Rocco Quality	Rockingham	10	12	2	-77%	16	34%	3	-73%	19	60%
Southern Shenandoah Totals		955	325	805	-16%	174	-47%	773	-19%	221	-32%

Note: The nutrient loads for Middle River STP in 1994 are compared to those from Staunton STP in 1985; and the loads for Middle River STP under the Regional Strategy are compared to those from Staunton and Verona STPs in 1985.

Table 6-5. Nonpoint Source Nutrient Loads for Southern Shenandoah Region

Based on Implementation of Proposed Regional Assessment

	1985 Nonpoint Loads (thousands of lbs)		Year 1994 Reported Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Augusta County	1,264	265	936	-26%	205	-23%
Highland County	56	9	46	-19%	9	-5%
Page County	364	75	288	-21%	63	-16%
Rockingham County	1,443	268	1,007	-30%	189	-30%
Southern Shenandoah	3,127	617	2,277	-27%	466	-24%

	1985 Nonpoint Loads (thousands of lbs)		Proposed Regional Strategy (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Augusta County	1,264	265	583	-54%	143	-46%
Highland County	56	9	36	-35%	8	-11%
Page County	364	75	213	-42%	49	-35%
Rockingham County	1,443	268	738	-49%	146	-45%
Southern Shenandoah	3,127	617	1,570	-50%	346	-44%

Table 6-6. Total Nutrient Loads for Southern Shenandoah Region

Based on Implementation of Proposed Regional Assessment

	1985 Controllable Loads (thousands of lbs)		Year 1994 Reported Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Augusta County	1,765	416	1,245	-29%	256	-38%
Highland County	56	9	46	-19%	9	-5%
Page County	393	86	293	-26%	68	-21%
Rockingham County	1,868	431	1,499	-20%	307	-29%
Southern Shenandoah	4,083	942	3,082	-25%	639	-32%

	1985 Controllable Loads (thousands of lbs)		Proposed Regional Strategy (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Augusta County	1,765	416	934	-47%	202	-51%
Highland County	56	9	36	-35%	8	-11%
Page County	393	86	229	-42%	57	-34%
Rockingham County	1,868	431	1,144	-39%	301	-30%
Southern Shenandoah	4,083	942	2,343	-43%	567	-40%

2. Northern Shenandoah Regional Assessment

Regional Description

The Northern Shenandoah region consists of one-quarter of the area of Virginia's Shenandoah-Potomac basin and includes all of Clarke, Frederick, Shenandoah and Warren Counties and the city of Winchester. The majority of the North Fork Shenandoah River and all of the main stem of the Shenandoah River are in this region. Based on 1994 data, agriculture and forestry are the major land uses, with 57% forested and 39% in farmland and pasture. Only 4% of the region's land use is urban or suburban.

Summary of Nutrient Loadings and Reduction Targets

In 1985, this region contributed 13% of the Shenandoah-Potomac basin's total controllable nitrogen load and 20% of the total controllable phosphorus load. In the Northern Shenandoah region in 1985, point sources contributed 33% of the loadings of both nutrients, and nonpoint sources contributed the other 67%. Six municipal and industrial wastewater treatment plants in the region are considered significant point sources. Table 6-7 provides regional loadings for 1985, 1994 and projected to the year 2000 under current programs.

Table 6-7. Total Nutrient Loads for Northern Shenandoah Region

Based on Implementation of Current & Planned State Programs

Year 1994 Progress to Date

	1985 Controllable Loads (thousands of lbs)		Year 1994 Reported Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Clarke County	388	60	327	-16%	53	-10%
Frederick County	834	164	808	-3%	128	-22%
Shenandoah County	796	136	700	-12%	106	-22%
Warren County	724	60	249	-66%	31	-48%
Northern Shenandoah	2,742	419	2,084	-24%	318	-24%

Year 2000 Projections

	1985 Controllable Loads (thousands of lbs)		Year 2000 Estimated Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Clarke County	388	60	317	-18%	53	-11%
Frederick County	834	164	858	3%	135	-18%
Shenandoah County	796	136	589	-26%	85	-38%
Warren County	724	60	324	-55%	40	-33%
Northern Shenandoah	2,742	419	2,088	-24%	313	-25%

Under current programs, by the year 2000 the region is expected to achieve a 0.654 million pound reduction in annual nitrogen loadings (24% reduction for the region) and a 0.106 million pound reduction in annual phosphorus loadings (25% reduction). This leaves a 0.443 million pound gap in reaching the 40% reduction goal for nitrogen and a 0.062 million pound gap in reaching the 40% goal for phosphorus.

Overview of the Northern Shenandoah Regional Assessment Process

The Northern Shenandoah assessment was cooperatively supervised by the chairperson of the Lord Fairfax Soil and Water Conservation District (LFSWCD), and the state regional team leader. The assessment included five regional meetings and additional meetings with various groups, including the board of supervisors of each county, Farm Bureau representatives, and the Frederick Winchester Service Authority Board.

The meetings included representatives of each of the four counties; the City of Winchester; the towns of Berryville, Front Royal, Strasburg and Woodstock; LFSWCD; Lord Fairfax PDC; the Friends of the Shenandoah River and the Friends of the North Fork of the Shenandoah River. At the second meeting, technical information was provided to these participants on nutrient loads and reductions targets, the Bay Program's computer models, and options for BNR at wastewater treatment plants in the region. Discussions were held regarding the approach of the regional assessment process. The participants in the assessment determined that the localities would individually consider developing local nutrient reduction assessments and the regional group would construct a "Regional Framework' that would be used to guide the development of local nutrient reduction plans.

At the third and fourth regional meetings, participants constructed a Regional Framework to guide local nutrient reduction plans. The Framework was adopted by the Lord Fairfax PDC and was then sent to local governments for final review. The only dissent on the Regional Framework was from the Frederick County Board of Supervisors.

The full Regional Framework includes a list of the benefits that would accrue to citizens in the region as a result of nutrient reduction. Several common goals were set forth. First, the region will focus on agricultural BMPs as the most cost-effective way to reduce nutrients. Second, each local strategy should combine cost effectiveness with shared responsibility. Finally, the region will look for economic incentives to encourage citizens to voluntarily implement nutrient reduction.

The Framework addresses the different types of nutrient sources: agriculture, municipal, industrial, residential and growth and development. A copy of the Regional Framework, adopted June 19, 1996 by the Lord Fairfax Planning District Commission, is provided in Appendix I.

The following pages include brief summaries of the Clarke County and Shenandoah County local nutrient reduction assessments, as adopted by the two county boards of supervisors. Status reports are provided for the counties of Frederick and Warren and the City of Winchester. The full regional assessment, including these local nutrient reduction plans, is also provided in Appendix I.

Local Nutrient Reduction Assessments for the Northern Shenandoah Region

Clarke County Nonpoint Source Nutrient Reduction Strategy

The Clarke County Nutrient Reduction Strategy, adopted by the Board of Supervisors, includes measures to close the annual nutrient gap of 100 thousand pounds of nitrogen and 57 thousand pounds of phosphorus. Nutrient loadings from Clarke County are mostly from nonpoint agricultural sources. Clarke County proposes increased cost-share funding for a range of BMPs. The primary means for reducing nutrient loads include farm plans, nutrient management, highly erodible land retirement, grazing land protection, animal waste control facilities, and septic pump-out requirements. Secondary methods will be erosion and sediment control, forest harvest management and urban runoff management. Agricultural BMPs, including farm plans and nutrient management plans, appear to be the most cost-effective BMPs available. The proposed numbers and/or acreages of nonpoint source BMPs included in the Clarke County assessment are provided in Appendix I.

Additional Soil and Water Conservation personnel will be needed to administer any additional cost-share funds for BMPs and to assist farmers in preparing and implementing these practices. Fully implemented, the proposed Clarke County plan will lead to a 52% reduction in controllable nitrogen loads and a 42% reduction in controllable phosphorus loads. The County is currently implementing a number of programs that will serve to maintain the nutrient cap.

Shenandoah County Nutrient Reduction Plan

The Shenandoah County Nutrient Reduction Plan was prepared by the County's Water Resources Steering Committee and approved by the Board of Supervisors. The Committee determined that implementing nutrient controls at the wastewater treatment plants in the County (all of which are relatively small) would be very expensive. The committee developed a plan that chose the most cost-effective methods of nutrient reduction but spread the costs over the entire population. In general, agricultural BMPs were found to be the most cost-effective methods. The plan also includes proposed measures to maintain year 2000 nutrient levels once the nutrient gap is closed.

Currently, Shenandoah County is projected to achieve a 29% reduction in nitrogen and a 40% reduction in phosphorus by the year 2000. The progress made so far by Shenandoah County is due in large part to the implementation of nutrient management planning and agricultural BMPs by the county's farmers. With a modest increase in the implementation of farm and forest plans, conservation tillage, and nutrient management, Shenandoah County can meet the nitrogen reduction goal. This reduction can be achieved by requiring all farmers and forest harvesters to have farm and/or forest plans prepared that would include soil and water conservation and nutrient management recommendations. To aid in implementation of these plans, the county requests additional state cost-share funds for BMPs. The county would contribute the cost of one part-time position at the LFSWCD to administer the cost-share program and assist in the preparation of farm and forest plans.

The county asks that the State Legislature enable counties to adopt an ordinance that requires that farm and forest owners have prepared, and file with the County, a farm and/or forest plan,

including soil conservation and nutrient management measures. The county intends for this ordinance to require only that the plans be prepared. Implementation shall remain voluntary.

Shenandoah County's Board of Supervisors has recently adopted two new ordinances which represent great strides toward implementation of nutrient reduction practices. The first is a stream buffer protection ordinance that requires all new development to be setback 100 feet from perennial streams. The buffer must also be maintained in natural vegetation. The second is a cluster ordinance for all residential zones that would require 60% open space preservation for Conservation Zoning and 45% open space preservation for Agriculture zoning.

Warren County Nutrient Reduction Status Report

In Warren County, a major point source reduction occurred in 1989 when the Avtex Rayon Plant ceased operation. The plant closing reduced nitrogen loads by 432 thousand pounds(82% of county's baseline controllable load) and phosphorus loads by 3 thousand pounds(9% of county's baseline controllable load). Shifts in agricultural land use from row crop to pasture also have reduced nutrient loadings. As a consequence, it is projected that by the year 2000 Warren County will exceed the 40% reduction goal for nitrogen and have a phosphorus nutrient gap of 4 thousand pounds.

Warren County staff developed a Nutrient Reduction Plan that included further nutrient reductions, particularly with regard to improved septic systems and opportunities for agricultural cost-share practices in the County. Two meetings were held with the Board of Supervisors on this plan and the Board determined that the septic system issue raised in the Plan warranted further consideration by a County Committee, which was then formed by the Board for that purpose. The Board adopted a resolution that supported nutrient and sediment reduction into tributaries and noted the County's past success in achieving nutrient reductions. The resolution also stated that the newly formed Nutrient Reduction Plan Committee will consider additional actions to be taken to reduce nutrient loadings in the County, while avoiding any mandates on Warren County citizens. The Committee has made the following recommendations to the Board:

- Provide information and instruction to subdivision associations, agricultural operations and golf courses regarding the need to provide buffers along the Shenandoah River and its tributaries.
- Have the Warren County Health Department conduct a county-wide survey to determine the extent of illegal dumping of sewage.
- Require regular inspection and pumping of private septic systems.
- Change the County Code to require larger lot sizes and/or larger septic systems (perk tests must show soil/leach field can accommodate a three-bedroom dwelling, at a minimum).
- Require a 100' vegetated buffer for all new riverfront residential development.
- Require manhole access for all new septic tanks.
- To develop and implement an education program allowing and promoting the alternate use and disposal of gray water and the utility of alternative wastewater disposal systems.
- To develop and implement an education program for homeowners on the proper use and disposal of fertilizers, pesticides and other potential water pollutants.
- Require all riverfront agricultural operations develop nutrient management plans in cooperation

with the Lord Fairfax Soil and Water Conservation District.

The agricultural BMPs, which were determined during the assessment to be potentially available for implementation under a cost-share scenario in Warren County, are included in the Northern Shenandoah Assessment in Appendix I. Implementation of these practices would place Warren County over the 40% reduction goal in both nitrogen and phosphorus loadings by year 2000.

Frederick County Nutrient Reduction Status Report

The Frederick County Board of Supervisors went on record as not supporting the language of the Regional Framework. A meeting was then held between the local and state coordinators of the Northern Shenandoah assessment and the Frederick County Board. At that meeting, the Board members expressed their concern that there had been insufficient involvement with the County's farming community. The Board also expressed concern over the effect that the nutrient cap would have on future growth and development in the County.

The Board agreed that the state technical assistance team could put together a list of agricultural practices, also known as a "strawman," that could potentially be available for implementation in the County. After that list was created, the state assistance team leader coordinated efforts with the County's agricultural community through the Virginia Farm Bureau (state and local) to ensure that their interests were represented in the regional assessment. The list of agricultural BMPs that could potentially be available for implementation in the County under a cost-share scenario is included in the Northern Shenandoah Assessment in Appendix I.

City of Winchester and the Frederick-Winchester Service Authority Status Report

The City of Winchester and the Frederick-Winchester Service Authority (FWSA) participated in the Shenandoah-Potomac Strategy assessment process. Concurrently, the FWSA voluntarily participated in a BNR feasibility study sponsored by the Environmental Protection Agency and conducted by VPI&SU. The VPI&SU investigator evaluated the Opequon wastewater treatment plant, which already has a nitrification process installed. The FWSA has also undertaken a “needs and capacity” study at the Opequon facility to prepare for future expansions or upgrades.

As a result of these parallel efforts, the FWSA Board held a meeting on September 16, 1996, to hear presentations by the state technical assistance team leader, the VPI&SU investigator and the engineering consultant who is conducting the needs and capacity study. At this meeting, the Board heard that the Opequon facility is efficiently designed for upgrade to BNR technology and that they could request cost-share funding for such an upgrade through the Strategy assessment process.

The nutrient reductions that would be achieved through the operation of BNR at the Opequon facility have been included in the Northern Shenandoah Assessment. The estimated costs for such an upgrade span a wide range, and this range has been included in the cost figures for the Strategy. However, the FWSA Board has not yet reached a final decision on whether they will propose the Opequon for cost-share funding and BNR upgrade through the Strategy.

Nutrient Loadings Under Proposed Northern Shenandoah Regional Assessment

Table 6-8 includes a summary of the proposed increases in BMP implementation by BMP practice with the associated added nitrogen and phosphorus reductions. The result of these recommended actions is a 54% reduction in nonpoint source nitrogen loading and a 44% reduction in nonpoint source phosphorus loading. The principle reductions are obtained through increased farm plans, nutrient management and grazing land protection.

Full implementation of the Northern Shenandoah Regional Strategy would achieve a 44% reduction in the total 1985 controllable nitrogen load and a 40% reduction in the total 1985 controllable phosphorus load. The nutrient reductions that would be achieved for each local jurisdiction under the proposed strategy are detailed in Tables 6-9, 6-10 and 6-11.

Costs for the Proposed Northern Shenandoah Assessment

The total cost for proposed nonpoint source nutrient reduction practices identified through the Northern Shenandoah Assessment is $2.58 million, which includes $80,000 for two additional staff at the Lord Fairfax Soil and Water Conservation District. Although two of the four counties (Clarke and Shenandoah) stated that they would help fund these positions, it is not yet known whether a full 50% of the $80,000 would be provided through local funding. If the FWSA chooses to upgrade the Opequon facility for BNR and to request state cost-sharing, the cost of that upgrade could range from $0.570 million to $2.850 million (or possibly higher). This brings the total cost for implementation of identified practices in the region to between $3.15 million and $5.43 million. (Note: cost figures for the Northern Shenandoah region shown in Table 7.1 do not include the $80,000 for two staff positions.)

Table 6-8. Nonpoint Source Nutrient Reductions for Northern Shenandoah Region

Based on Implementation of Proposed Regional Assessment

		Total Proposed Coverage		Reductions (lbs/year)		Increased Ac	Added Reductions Ach'd	
BMP Treatment	units	Coverage	Percent	Nitrogen	Phosphorus	of Coverage	Nitrogen	Phosphorus
Conservation Tillage	acres	36,833	67.8%	31,428	2,972	5,714	25,714	2,385
Farm Plans	acres	95,236	65.1%	54,396	15,274	35,990	16,815	4,909
Nutrient Management	acres	80,326	54.9%	309,168	41,137	44,497	150,654	20,560
Highly Erodible Land Retirement	acres	8,751	2.6%	96,846	14,063	3,990	48,029	6,691
Grazing Land Protection	acres	42,857	23.3%	123,932	7,998	40,262	116,512	7,514
Stream Protection	acres	1,794	-----	2,508	185	925	1,356	95
Cover Crops	acres	3,012	-----	21,202	1,575	500	3,520	261
Grass Filter Strips	acres	550	-----	5,208	616	550	5,208	616
Woodland Buffer Filter Area	acres	600	-----	11,489	1,569	600	11,489	1,569
Forest Harvesting	acres	4,830	100.0%	60,464	1,166	0	0	0
Animal Waste Control Facilities	systems	134	-----	99,264	18,971	1	100	23
Erosion & Sediment Control	acres	691	100.0%	7,330	3,743	0	0	0
Urban SWM/BMP Retrofits	acres	0	0.0%	0	0	0	0	0
Urban Nutrient Management	acres	514	13.0%	648	57	132	167	15
Septic Pumping	systems	0	-----	0	0	0	0	0
Shoreline Erosion Protection	linear feet	0	-----	0	0	0	0	0
Total Pounds Reduced:				823,883	109,326		379,562	44,639
Adjustment for Land Use Changes:				(168,766)	(11,877)			
Adjusted Reduction:				992,649	121,203			
Nonpoint Controllable Amount:				1,839,388	278,428			
Percent Reduction:				53.97%	43.53%			

Table 6-9. Point Source Nutrient Loads Northern Shenandoah Region

(in thousand of pounds per year)

		1985 Nutrient Loads		1994 Loads & Percent Change				Regional Strategy Loads & Percent Change			
Facility	Location	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change	Nitrogen	% Change	Phosphorus	% Change
Abrams Creek	Frederick	16	5	0	-100%	0	-100%	0	-100%	0	-100%
FWSA Opequon	Frederick	0	0	258	42%	34	-45%	107	-41%	23	-63%
Parkins Mill	Frederick	0	0	29	---	4	---	95	---	12	---
Winchester	Winchester	167	57	0	-100%	0	-100%	0	-100%	0	-100%
Aileen Inc.	Shenandoah	13	10	17	30%	9	-15%	0	-100%	0	-100%
Rocco Farm	Shenandoah	123	15	206	67%	26	67%	206	67%	26	67%
Strasburg	Shenandoah	35	12	26	-27%	3	-71%	47	32%	6	-48%
Woodstock	Shenandoah	22	7	48	115%	6	-16%	38	70%	5	-34%
Avtex Fibers	Warren	432	3	0	-100%	0	-100%	0	-100%	0	-100%
Front Royal	Warren	94	31	104	10%	13	-57%	191	103%	25	-21%
Northern Shenandoah Totals		902	140	688	-24%	95	-32%	684	-24%	96	-32%

Note: The nutrient loads for FWSA Opequon STP in 1994 and under the Regional Strategy are compared to those from Abrams Creek and Winchester STPs in 1985. The Parkins Mill STP is a recent addition to the load totals and no comparison to 1985 is possible.

Table 6-10. Nonpoint Source Nutrient Loads for Northern Shenandoah Region

Based on Implementation of Proposed Regional Assessment

	1985 Nonpoint Loads (thousands of lbs)		Year 1994 Reported Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Clarke County	388	60	327	-16%	53	-10%
Frederick County	651	102	521	-20%	90	-11%
Shenandoah County	602	91	403	-33%	62	-33%
Warren County	198	26	146	-26%	18	-32%
Northern Shenandoah	1,839	278	1,396	-24%	223	-20%

	1985 Nonpoint Loads (thousands of lbs)		Proposed Regional Strategy (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Clarke County	388	60	163	-58%	35	-41%
Frederick County	651	102	408	-37%	76	-25%
Shenandoah County	602	91	214	-64%	37	-60%
Warren County	198	26	62	-69%	9	-63%
Northern Shenandoah	1,839	278	847	-54%	157	-44%

Table 6-11. Total Nutrient Loads for Northern Shenandoah Region

Based on Implementation of Proposed Regional Assessment

	1985 Controllable Loads (thousands of lbs)		Year 1994 Reported Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Clarke County	388	60	327	-16%	53	-10%
Frederick County	834	164	808	-3%	128	-22%
Shenandoah County	796	136	700	-12%	106	-22%
Warren County	724	60	249	-66%	31	-48%
Northern Shenandoah	2,742	419	2,084	-24%	318	-24%

	1985 Controllable Loads (thousands of lbs)		Proposed Regional Strategy (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Clarke County	388	60	163	-58%	35	-41%
Frederick County	834	164	610	-27%	111	-32%
Shenandoah County	796	136	505	-37%	73	-46%
Warren County	724	60	253	-65%	34	-43%
Northern Shenandoah	2,742	419	1,531	-44%	253	-40%

3. Northern Virginia Regional Assessment

Regional Description

The Northern Virginia region includes the counties of Arlington, Fairfax, Fauquier, Loudoun, Prince William and Stafford and the towns and cities within those borders. It encompasses about one-third of the land area of Virginia's Shenandoah-Potomac basin, and includes several important tributaries to the Potomac River. Approximately 1.7 million people reside in the region, nearly one-third of the state's population. Based on 1994 data, the land cover is about 39% forested, 31% farmland and pasture, and 30% urban/suburban land.

Summary of Nutrient Loadings and Reduction Targets

This region contributed 61% (12.505 million pounds) of the total 1985 controllable nitrogen load, and 31% (0.658 million pounds) of the controllable phosphorus load in Virginia's Shenandoah-Potomac basin. Within the region, 66% of the nitrogen is contributed from point sources while 85% of the phosphorus is contributed from nonpoint sources. Loadings from point sources and nonpoint sources were contributed on a percentage basis as follows:

Table 6-12. Northern Virginia Region Baseline Nutrient Loads by Source Category

		Nonpoint Source	
	Point Source	Agricultural	Urban
Nitrogen Load	66%	23%	11%
Phosphorus Load	16%	60%	24%

Under current programs, by the year 2000 the region is expected to experience essentially no change in nitrogen (0%) and achieve a 123 thousand pound per year decrease in phosphorus (-19%). A key reason for the increasing nitrogen load is the expected population increase in the region. Based on 1990 census data and Virginia Employment Commission figures, the Northern Virginia region's 2000 population is projected to be nearly 26% greater than the 1985 figure.

For nitrogen, this leaves a 4.971 million pounds per year gap in reaching the 40% reduction goal. For phosphorus, this leaves a 0.124 million pounds per year gap in reaching the 40% nutrient reduction goal. Table 6-13 provides regional loadings for 1985, 1994 and projected to the year 2000 under current programs.

Table 6-13. Total Nutrient Loads for Northern Virginia Region

Year 1994 Progress to Date

	1985 Controllable Loads (thousands of lbs)		Year 1994 Reported Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Arlington County	1,733	56	978	-44%	13	-76%
Fairfax County	5,703	136	6,513	14%	115	-15%
Fauquier County	981	133	896	-9%	122	-8%
Loudoun County	1,240	191	1,056	-15%	169	-12%
Prince William County	1,678	104	1,680	0%	85	-18%
Stafford County	356	31	298	-16%	26	-16%
Blue Plains STP (VA)	814	7	1,142	40%	13	91%
Northern Virginia	12,505	658	12,563	0%	543	-17%

Year 2000 Projections

	1985 Controllable Loads (thousands of lbs)		Year 2000 Estimated Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Arlington County	1,733	56	1,101	-36%	14	-76%
Fairfax County	5,703	136	6,395	12%	108	-21%
Fauquier County	981	133	854	-13%	116	-13%
Loudoun County	1,240	191	1,125	-9%	178	-7%
Prince William County	1,678	104	1,702	1%	79	-24%
Stafford County	356	31	361	1%	22	-30%
Blue Plains STP (VA)	814	7	936	15%	19	173%
Northern Virginia	12,505	658	12,475	-0%	535	-19%

Overview of the Northern Virginia Regional Assessment Process

The Commonwealth has attempted to establish a strong local/state government partnership to carry out the tributary strategy development process. Using basic data provided by the state on the sources and magnitude of nutrient loads, and efficiencies and costs of control options, it was planned that local governments would set the direction for future nutrient reduction efforts by selecting the options most appropriate for the Northern Virginia region.

However, the assessment process as originally envisioned for the Northern Virginia region was complicated by several factors that prevented a comprehensive discussion of the options for closing the nutrient reduction gap. As a result, the assessment which follows is essentially a state-developed strawman that attempts to integrate updated information provided by the localities while suggesting nutrient control actions that appear to be practical, cost-effective and equitable. Therefore, it is important to note that given the limited time frame and complexity of this topic, local elected officials have not yet fully reviewed and concurred with the "strawman" assessment. It is hoped that continued discussions will result in agreement on the practices set forth in this strawman or on some other form of regional assessment.

One key factor that influenced the assessment process was the need for a better local understanding of the tools used by the federal/interstate Chesapeake Bay Program (CBP) to estimate nutrient loads and predict water quality improvements resulting from load reductions. Knowledge and acceptance of these monitoring and modeling programs was necessary before any meaningful discussion on nutrient control options could take place. At the request of Northern Virginia localities

operating large wastewater plants in the metropolitan Washington area, three workshops were conducted by the EPA-CBP in March and April 1996, where information was exchanged about monitoring results, and model construction, capabilities, output, and validity. This information formed the basis of the CBP's 1991-92 reevaluation of the nutrient reduction goal. These technical sessions were beneficial to the local representatives, but apparently the available information did not fully answer questions about the quantifiable habitat and living resource benefits that the reduction goal will achieve. A fourth workshop is being planned for the spring of 1997 to discuss the policy implications raised at the earlier meetings. Also, the CBP's 1997 Reevaluation of its Nutrient Reduction Strategy program will provide additional opportunities to further document the benefits resulting from nutrient reductions.

The end result of this process was the development of the Northern Virginia Regional Strawman Assessment which is provided in Appendix J.

Summary of Northern Virginia Region Assessment Recommendations (State Strawman)

1) Increase use and coverage of nonpoint source BMPs for both agricultural and urban lands as shown in Table 6-14.

2) Retrofit all wastewater treatment plants in the Region, with a design capacity of 0.5 million gallons per day (M.D.) or greater, with year-round BNR or an equivalent technology. Capital cost is estimated at $84-87 million (figure is only for treatment needed beyond current or pending permit requirements, in January 1996 dollars, with a system service life of 20 years). The exception to this recommendation is the Upper Occoquan Water Reclamation Plant (see further discussion on page 66).

3) Review and confirm future daily flow projections and design capacities at Northern Virginia region treatment plants. At plants not already doing so, institute effluent monitoring for total nitrogen and total phosphorus using accepted sampling protocols and analytical methods.

4) Review and confirm cost figures for BNR retrofits. Owners and their consultants are to develop pre-design engineering cost estimates for unit processes essential for BNR level treatment. Cost figures should be only for retrofits needed to go beyond current or pending mandatory treatment requirements.

5) For regional acceptance of program model goals and results, the federal/interstate Chesapeake Bay Program (CBP) must continue to be responsive to the information needs of the local governments. The CBP's 1997 Reevaluation of its Nutrient Reduction Strategy program should be structured to produce results that further explain the habitat and living resource benefits that the nutrient reduction goal will achieve, as well as further demonstrate the validity and credibility of the predictive modeling tools used.

6) State and local representatives should continue the effort to further develop the Regional Pilot Program (RPP) adopted by the Washington Council of Governments (COG) Board in June 1994, and reaffirmed October 1996, consistent with any schedule and content determined by

the COG Board and any action of the General Assembly. The RPP has recommended conditions under which it should be implemented, and these would be elements of a two-part Memorandum of Understanding. The first element is to provide cost-share grants to address funding needs identified for each plant, and the second is to have plant retrofits proceed under defined criteria for pilot testing, certain operational issues, and progress toward full implementation of nitrogen removal, as laid out in the RPP.

7) The Virginia Association of Municipal Wastewater Agencies (VAMWA) has produced an official position paper on Virginia=s nutrient reduction goals. It has received strong support from the VAMWA membership at all levels including Boards, Commissions, Councils, Executives, and staff. Therefore, the VAMWA position should be considered as a primary implementation mechanism for point source nutrient reductions. VAMWA's position supports installation of BNR technology at plants within the Shenandoah-Potomac basin conditioned on several commitments by the Commonwealth, principally:

   a) Grant funding of at least 50% for construction of nutrient removal systems. It is proposed that the General Assembly create a joint study committee to identify new sources of funding for this cost-share program.
   b) Implementation through agreement, not by permit. This is consistent with the Commonwealth's voluntary, cooperative tributary strategy program approach.
   c) Future nutrient cap controls based on equity and sound science.

Nutrient Loadings Under the Proposed Northern Virginia Regional Assessment

Upon implementation of this strawman assessment, the projected reductions for the Northern Virginia region are estimated at 34% for nitrogen and 23% for phosphorus. Both figures are short of the 40% reduction goal. Discussions with the Northern Virginia local governments have been initiated to identify possible measures, even beyond the expanded BMP coverage and point source retrofits suggested by the strawman, that could close this gap.

Table 6-14 provides a summary of the proposed increases in BMP implementation, by practice, and the associated nitrogen and phosphorus reductions. Nutrient reductions for each local jurisdiction under the proposed strawman assessment are fully detailed in Tables 6-15, 6-16 and 6-17. Note that adjustments were made to the extent of shoreline protection assigned to the Northern Virginia region due to reevaluation by staff at DCR of the specifics of the 1992 VIMS study that provided the basis of the reductions credited to this region and listed in the final comment draft of this document. The tidal shore in this region does not experience high-energy wave action and the significant corresponding erosion rate that can be found along the shores of Northumberland and Westmoreland counties. Therefore, nutrient reductions previously credited to this region have been eliminated until further research can be conducted.

Discussions continue regarding conservation easements, agricultural land conversions from cropland to pasture/hayland, installation of animal waste control structures and implementation of BMPs outside the state cost-share program. Also, some urban localities are reviewing data

availability on storm water retrofits. If these measures can be quantified in terms of nutrient load reduction, they will contribute to the assessment, but are not expected to provide all the reduction needed to meet the regional goal. Many options have the potential to "close the gap,@ but involve use of costly practices with diminishing returns in terms of pounds removed per dollar spent.

Point source retrofits for nitrogen removal could approach the limits of technology at those plants where it is most cost effective to do so. However, this is not considered equitable in light of the significant nutrient (phosphorus) reductions, that were accomplished in the Northern Virginia region prior to 1985, which the region cannot credit toward their 40% nutrient reduction target. If the practical limits of implementation, as set forth in the strawman, are accepted as the Region's contribution to the Shenandoah-Potomac Strategy, then additional, cost-effective reductions could be achieved in other regions and credited through a nutrient trading system.

Cost of the Proposed Northern Virginia Strawman Assessment

The total cost of the proposed Northern Virginia strawman assessment is approximately $86-89 million, with about $84-87 million for upgrading wastewater treatment plants and the remaining for agricultural and urban BMPs.

(Note: The above figures reflect a reduction in cost, relative to the costs presented in the October 1996 draft Strategy, due to the fact that the UOSA facility is not being recommended for upgrade. Please see page 66 for an explanation of this change.)

Table 6-14. Nonpoint Source Nutrient Reductions for Northern Virginia Region

Based on Implementation of Proposed Regional Assessment

BMP Treatment	units	Total Proposed Coverage		Reductions (lbs/year)		Increased Ac	Added Reductions Ach'd	
		Coverage	Percent	Nitrogen	Phosphorus	of Coverage	Nitrogen	Phosphorus
Conservation Tillage	acres	65,738	85.9%	0	0	0	0	0
Farm Plans	acres	150,104	76.5%	69,368	18,450	13,840	6,752	1,724
Nutrient Management	acres	56,352	28.7%	66,017	5,930	32,120	38,409	3,528
Highly Erodible Land Retirement	acres	8,420	2.3%	92,072	13,539	2,646	34,027	4,873
Grazing Land Protection	acres	11,838	7.2%	37,726	2,588	5,163	16,423	1,100
Stream Protection	acres	2,204	-----	3,426	249	754	1,176	85
Cover Crops	acres	931	-----	5,431	558	318	2,343	180
Grass Filter Strips	acres	505	-----	5,442	669	467	5,013	616
Woodland Buffer Filter Area	acres	710	-----	15,434	2,191	699	15,232	2,163
Forest Harvesting	acres	4,678	100.0%	67,038	1,136	0	0	0
Animal Waste Control Facilities	systems	27	-----	40,602	7,927	0	0	0
Erosion & Sediment Control	acres	6,396	100.0%	83,810	41,867	0	0	0
Urban SWM/BMP Retrofits	acres	4,240	1.5%	10,165	1,110	1,156	2,772	303
Urban Nutrient Management	acres	7,327	12.5%	11,117	999	3,621	5,532	497
Septic Pumping	systems	127	-----	29,427	0	0	0	0
Shoreline Erosion Protection	linear feet	0	-----	0	0	0	0	0
Total Pounds Reduced:				537,074	97,214		127,678	15,068
Adjustment for Land Use Changes:				(308,969)	(31,889)			
Adjusted Reduction:				846,043	129,103			
Nonpoint Controllable Amount:				4,306,736	555,591			
Percent Reduction:				19.64%	23.24%			

Table 6.15 Point Source Nutrient Loads Northern Virginia Region

(in thousand of pounds per year)

		1985 Nutrient Loads		1994 Loads & Percent Change				Regional Strategy Loads & Percent Change			
Facility	Location	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change	Nitrogen	% Change	Phosphorus	% Change
Blue Plains (VA)	DC	814	7	1,142	40%	13	91%	936	15%	19	173%
Arlington	Arlington	1,642	47	887	-46%	5	-90%	724	-56%	5	-89%
Lower Potomac	Fairfax	1,906	14	1,842	-16%	10	-41%	1,002	-54%	11	-30%
Little Hunting Ck	Fairfax	279	2	0	-100%	0	-100%	0	-100%	0	-100%
UOSA	Fairfax	597	1	1,216	103%	3	266%	539	-10%	4	350%
Alexandria	Alexandria	1,994	16	2,546	28%	6	-66%	921	-54%	7	-60%
Leesburg	Loudoun	65	2	136	108%	18	676%	97	48%	21	787%
Purcellville	Loudoun	14	5	19	33%	2	-48%	10	-31%	2	-57%
Dale City #1	Pr.William	91	1	97	6%	1	-27%	85	-7%	1	9%
Dale City #8	Pr.William	38	1	99	159%	<1	-62%	43	11%	<1	-53%
Mooney	Pr.William	609	4	665	9%	4	-5%	320	-48%	5	35%
Quantico	Pr.William	83	1	84	1%	<1	-54%	34	-59%	<1	-50%
Aquia	Stafford	65	2	39	-40%	1	-49%	122	87%	2	2%
Northern Virginia Totals		8,198	103	8,771	7%	63	-39%	4,832	-41%	78	-24%

Note: The nutrient loads for Lower Potomac STP in 1994 and under the Regional Strategy are compared to those from Lower Potomac and Little Hunting Creek STPs in 1985.

Table 6-16. Nonpoint Source Nutrient Loads for Northern Virginia Region

Based on Implementation of Proposed Regional Assessment

	1985 Nonpoint Loads (thousands of lbs)		Year 1994 Reported Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Arlington County	92	9	91	-1%	9	-2%
Fairfax County	926	103	910	-2%	97	-6%
Fauquier County	981	133	896	-9%	122	-8%
Loudoun County	1,161	184	901	-22%	148	-19%
Prince William County	857	98	735	-14%	80	-18%
Stafford County	291	29	259	-11%	25	-14%
Northern Virginia	4,307	556	3,792	-12%	481	-14%

	1985 Nonpoint Loads (thousands of lbs)		Proposed Regional Strategy (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Arlington County	92	9	87	-6%	8	-10%
Fairfax County	926	103	860	-7%	85	-17%
Fauquier County	981	133	821	-16%	112	-16%
Loudoun County	1,161	184	783	-33%	132	-28%
Prince William County	857	98	683	-20%	71	-28%
Stafford County	291	29	229	-21%	18	-37%
Northern Virginia	4,307	556	3,461	-20%	426	-23%

Table 6-17. Total Nutrient Loads for Northern Virginia Region

Based on Implementation of Proposed Regional Assessment

	1985 Controllable Loads (thousands of lbs)		Year 1994 Reported Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Arlington County	1,733	56	978	-44%	13	-76%
Fairfax County	5,703	136	6,513	14%	115	-15%
Fauquier County	981	133	896	-9%	122	-8%
Loudoun County	1,240	191	1,056	-15%	169	-12%
Prince William County	1,678	104	1,680	0%	85	-18%
Stafford County	356	31	298	-16%	26	-16%
Blue Plains STP (VA)	814	7	1,142	40%	13	91%
Northern Virginia	12,505	658	12,563	0%	543	-17%

	1985 Controllable Loads (thousands of lbs)		Proposed Regional Strategy (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
Arlington County	1,733	56	811	-53%	13	-76%
Fairfax County	5,703	136	3,321	-42%	107	-22%
Fauquier County	981	133	821	-16%	112	-16%
Loudoun County	1,240	191	889	-28%	155	-19%
Prince William County	1,678	104	1,164	-31%	78	-26%
Stafford County	356	31	350	-2%	20	-34%
Blue Plains STP (VA)	814	7	936	15%	19	173%
Northern Virginia	12,505	658	8,292	-34%	504	-23%

4. Lower Potomac Regional Assessment

Regional Description

The Lower Potomac region encompasses approximately 7% of the land area in Virginia's Shenandoah-Potomac basin and includes portions of King George, Westmoreland, and Northumberland Counties and the Town of Colonial Beach. It includes several significant tributaries to the Potomac River, including Upper Machodoc Creek, Mattox Creek, Nomini Creek, Lower Machodoc Creek, Yeocomico River, Coan River and Little Wicomico River. Based on 1994 data, approximately 63% of the area of this region is forested, 31% is farmland and pasture, and 6% is urban. Two significant point sources of nutrients are located in this region, one in King George County and the other in the Town of Colonial Beach.

Summary of Nutrient Loadings and Reduction Targets

The Lower Potomac region contributed 5% (1.098 million pounds) of the total 1985 controllable nitrogen load and 5% (0.115 million pounds) of the controllable phosphorus load in Virginia's Shenandoah-Potomac basin. In 1985, nonpoint sources contributed 97% of the region's nitrogen load and 92% of the region's phosphorus load. Table 6-18 provides regional loadings for 1985, 1994 and projected to the year 2000 under current programs.

Table 6-18. Total Nutrient Loads for Lower Potomac Region
Based on Implementation of Current & Planned State Programs

Year 1994 Progress to Date

	1985 Controllable Loads (thousands of lbs)		Year 1994 Reported Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
King George County	249	26	219	-12%	19	-25%
Northumberland County	304	30	215	-29%	16	-47%
Westmoreland County	545	60	394	-28%	27	-55%
Lower Potomac	1,098	115	828	-25%	62	-46%

Year 2000 Projections

	1985 Controllable Loads (thousands of lbs)		Year 2000 Estimated Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
King George County	249	26	215	-14%	18	-31%
Northumberland County	304	30	197	-35%	12	-59%
Westmoreland County	545	60	346	-36%	16	-74%
Lower Potomac	1,098	115	758	-31%	46	-60%

Under current programs, by the year 2000 the region is expected to achieve a 340 thousand pound reduction in annual nitrogen loads (31% regional reduction) and a 69 thousand pound reduction in annual phosphorus loads (60% reduction). For nitrogen, this leaves a 99 thousand pound gap in reaching the 40% goal. The region is projected to surpass the 40% phosphorus reduction goal

by the year 2000.

Overview of the Lower Potomac Regional Assessment Process

Each of the three counties and the one incorporated town, Colonial Beach, has adopted a Chesapeake Bay Preservation Act (CBPA) program in which the entire jurisdiction is subject to the performance criteria of the CBPA Regulations. These management measures provided a strong framework for the regional assessment that was conducted and for continued efforts to reduce nutrient loadings.

A series of meetings took place between March and September 1996 among local government elected officials and staff, PDC staff, representatives of soil and water conservation districts, and other representatives of various citizen groups. The purpose of the meetings was to forge a consensus on the most practical and cost-effective combination of measures to reach the 40% nutrient reduction goal.

Steps taken in the Lower Potomac region were to review loading estimates and suggest refinements to state agency staff. A strawman regional assessment was prepared for review and discussion among the regional participants. This assessment was then adjusted and refined based on input from the various regional participants. The end result of this process was the development of the Lower Potomac Regional Assessment which is included in Appendix K.

Summary of Lower Potomac Region Assessment Recommendations

The nutrient reduction scenario crafted by the Lower Potomac regional participants relies on increased activity in a number of different areas; however, nutrient reductions resulting from increased use of agricultural BMPs are paramount. This is appropriate since more than ninety-five percent of the 1985 controllable nutrient loads within the Lower Potomac region can be traced back to nonpoint sources. Of that figure, over eighty percent of the total controllable nutrient loads are from cropland. The remaining nutrient loads are split nearly evenly across the other land use categories of non-rural, point source, and agricultural activities other than crop production.

In this regional assessment, all reductions beyond those projected under current funding levels of state and federal programs will be achieved through expansion of nonpoint source BMPs. Expansion of these practices results in a 40% decrease in the annual controllable nitrogen load and a 67% decrease in the annual controllable phosphorus load by the year 2000 from point and nonpoint sources combined. Therefore, any reductions that may be attributable to potential changes at the wastewater treatment plants (WWTPs) in this region, Colonial Beach and Dahlgren plants, could be used to augment and/or offset those nonpoint source reduction measures shown under the regional assessment. It is possible that with further upgrades or other modifications at the WWTPs, the region could meet or exceed 40% reduction of nitrogen. In any case, future population growth and the associated increased loads from the wastewater treatment plants will require continual upgrades to maintain the nutrient cap.

Under the federal/interstate Chesapeake Bay Program(CBP), Virginia has been involved in a federally funded technical support study on the use of biological nutrient removal (BNR) at wastewater treatment plants in the Shenandoah-Potomac basin. Regional participants recommended that the two municipal wastewater treatment plants, Colonial Beach and Dahlgren, take part in the study. Colonial Beach has formally requested inclusion in the study.

The regional participants agreed that an increase is feasible in the number of acres employing conservation versus conventional tillage methods from the 1994 figure of 51% (of all potential treatment coverage that could occur for the BMP) to approximately 71% by the year 2000. They also agreed that an increase in this practice would have a high impact in the region, relative to other possible nutrient reduction measures that could be taken. The group went on to note that this goal of 71% is feasible on average over the long term, although there could be an occasional growing season when market forces could disrupt the typical two-year, three-crop rotation practices commonly in use in this region. In these years, this level of implementation would probably not occur.

Over the long term, significant shifts in type of crop production could also impact crop rotation practices. However, group participants believe that recent agricultural indicators point to continued promotion of conservation tillage for the crop production and rotation practices expected for the next several years in this region. Participants expect vegetable farming to increase in the region, and they agreed that promotion and demonstration of no-till methods of vegetable farming could yield significant benefits in nutrient reduction.

The regional participants agreed that an increase in the number of acres under nutrient management plans from a 1994 figure of 21% to approximately 55% by the year 2000 is feasible, given certain conditions. Those conditions are that cost-share funds, 50% or better, be provided for nutrient management BMPs such as, but not limited to: tissue testing, split applications of nitrogen (especially on leachable soils), soil testing, cover crops, and use of banding equipment for fertilizer.

Tissue testing requires laboratory analysis methods taking, on average, three days to complete. Therefore, this and the costs associated with testing are viewed as barriers to more wide-spread use of the practice. Research is on-going to develop an inexpensive in-field tissue test, although some experts believe that a practical and relatively accurate field test applicable to Virginia crop production is still a decade away. Meeting participants suggested that the state could provide resources to help promote development of an in-field tissue testing procedure that was accurate for more than one crop.

The regional participants also recommended that methods be devised to more accurately document the number of acres under both voluntary nutrient management and conservation tillage which are not now completely accounted for. They estimated that there may be significant acres in this region which fall into this voluntary category. It was recommended that a grant or other funding source be found to refine the Voluntary BMP Survey to focus on this region. Participants also agreed there was a need to develop a database, in a format which would be useful to the public, of information obtained from water quality monitoring efforts.

The regional participants acknowledged that since much of the land farmed in the region is rented, there is a need to determine how to better target the farm manager or land user, in addition to the farm owner, for education in nutrient management and other conservation farming techniques. They agreed there is a need to increase the communication and involvement between local governments and the agricultural water quality specialists who develop farm plans in Chesapeake Bay Preservation Areas.

In general, the group believed that the existing use of state and federal resources should be studied to eliminate overlap and to increase productivity and efficiency of delivery to end-users. While there may be a need for increased staffing in this region, two factors make it difficult to say with certainty that additional staff resources will, in fact, be needed. First, the Nutrient Certification Program established by the Department of Conservation and Recreation is in its infancy, and the effect that private nutrient management consultants may have on nutrient reductions in the region has not yet been established. Second, the Chesapeake Bay Local Assistance Board has given Notice of Intent to consider amending the Chesapeake Bay Preservation Act Designation and Management Regulations to achieve (among other objectives) more water quality protection practices.

The regional participants recognized that establishing woodland buffer filter areas would have a high impact on nutrient reduction. The group suggested the Department of Game and Inland Fisheries' wildlife management plans and/or other similar programs within the framework of the state's agricultural tax incentive program include establishment of suitable food patches in the buffers to attract deer and other wildlife. Hunters would then pay fees to hunt in these wildlife management zones bordering waterways. The group agreed that provision of cost-share funds or other financial incentive measures would encourage farmers to plant marshlands in millet or other grains attractive to water fowl. The assessment proposes the acreage devoted to woodland buffer areas be increased from the zero currently designated as such in 1994 to 240 acres by the year 2000.

The regional participants also agreed that urban nutrient management, modification of lawn fertilizer use by homeowners and others, was a critical component of an effective nutrient reduction strategy in this region, since residential development (particularly waterfront residential) is expected to continue. The group believes that educational efforts such as workshops, recycling efforts, and the master gardener program are valuable approaches, and should be encouraged and funded. The group also supports the idea of requiring, or aggressively promoting, soil testing by commercial lawn care companies before they apply fertilizer to their customers' properties. Furthermore, the media should be used aggressively to educate the public on conservation practices.

Regional participants do not expect a significant increase in the use of cover crops beyond what is expected under current programs and practices in this region, therefore the regional assessment assumes no increased nutrient reduction from this practice. Furthermore, some participants expressed concern that the recent decision by the State Cost Share Board to eliminate the small grain cover crop practices from the BMP cost-share program, beginning in 1998, may reduce the practice below existing levels of usage. Participants agreed that cost-share funding for small grain cover crop practices should be retained.

Additional recommendations are described in the complete Lower Potomac regional assessment, provided in Appendix K.

Nutrient Reductions Under the Proposed Lower Potomac Regional Assessment

Under this assessment, the load reductions in the Lower Potomac region are projected to be 40% for nitrogen and 67% for phosphorus. Table 6-19 provides a summary of the proposed increases in BMP implementation for each type of practice and the associated nitrogen and phosphorus reductions. The nutrient reductions for each local jurisdiction under the proposed assessment are detailed in Tables 6-20, 6-21 and 6-22. Note that adjustments were made to the extent of shoreline protection assigned to the Lower Potomac region due to reevaluation by staff at DCR of the specifics of the 1992 VIMS study that provided the basis of the original reductions credited to this region and listed in the final comment draft of this document. The tidal shore of King George County experiences only a portion of the high-energy wave action and the significant corresponding erosion rate that can be found extensively along the shores of Northumberland and Westmoreland counties. Therefore, the number of feet of shoreline protected in this region have been recalculated. In addition, analysis of the soil composition found along the shoreline in this region reveals a higher incidence of nitrogen and phosphorous within the soils that are prevented from eroding into the Potomac River by shoreline protection measures. This leads to an increase in the nutrient reduction efficiency of this practice when implemented in this region, therefore nutrient reductions were recalculated accordingly.

Cost of the Proposed Lower Potomac Regional Assessment

The estimated cost for implementation of the proposed Lower Potomac regional assessment is $0.49 million.

Table 6-19. Nonpoint Source Nutrient Reductions for Lower Potomac Region

Based on Implementation of Proposed Regional Assessment

		Total Proposed Coverage		Reductions (lbs/year)		Increased Ac	Added Reductions Ach'd	
BMP Treatment	units	Coverage	Percent	Nitrogen	Phosphorus	of Coverage	Nitrogen	Phosphorus
Conservation Tillage	acres	38,765	70.6%	135,492	12,143	8,457	47,237	4,245
Farm Plans	acres	52,866	80.7%	47,548	8,320	0	(10,065)	(1,771)
Nutrient Management	acres	35,734	54.5%	102,336	4,684	12,168	31,542	1,501
Highly Erodible Land Retirement	acres	3,515	4.8%	44,045	5,505	1,150	16,710	2,403
Grazing Land Protection	acres	416	5.6%	1,438	97	0	0	0
Stream Protection	acres	0	-----	0	0	0	0	0
Cover Crops	acres	4,372	-----	36,725	2,842	0	0	0
Grass Filter Strips	acres	770	-----	8,698	1,071	330	3,729	459
Woodland Buffer Filter Area	acres	240	-----	5,484	780	240	5,484	780
Forest Harvesting	acres	1,492	100.0%	18,811	227	0	0	0
Animal Waste Control Facilities	systems	5	-----	8,250	1,615	0	0	0
Erosion & Sediment Control	acres	167	100.0%	2,253	1,127	0	0	0
Urban SWM/BMP Retrofits	acres	115	0.9%	284	31	0	0	0
Urban Nutrient Management	acres	139	10.0%	215	19	0	0	0
Septic Pumping	systems	40	-----	9,497	0	0	0	0
Shoreline Erosion Protection	linear feet	22,301	-----	60,540	39,453	0	0	0
Total Pounds Reduced:				481,616	77,913		94,637	7,618
Adjustment for Land Use Changes:				15,904	2,193			
Adjusted Reduction:				465,712	75,720			
Nonpoint Controllable Amount:				1,069,696	105,624			
Percent Reduction:				43.54%	71.69%			

Table 6-20. Point Source Nutrient Loads Lower Potomac Region

(in thousand of pounds per year)

		1985 Nutrient Loads		1994 Loads & Percent Change				Regional Strategy Loads & Percent Change			
Facility	Location	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change	Nitrogen	% Change	Phosphorus	% Change
Bayberry	King George	1	<1	0	-100%	0	-100%	0	-100%	0	-100%
Dahlgren	King George	5	2	11	100%	1	-52%	28	400%	2	-22%
Colonial Beach	Westmoreland	23	8	26	15%	6	-21%	26	15%	6	-21%
Lower Potomac Totals		28	10	38	32%	7	-27%	55	92%	8	-21%

Note: The nutrient loads for Dahlgren STP in 1994 and under the Regional Strategy are compared to those from Dahlgren and Bayberry STPs in 1985.

Table 6-21. Nonpoint Source Nutrient Loads for Lower Potomac Region

Based on Implementation of Proposed Regional Assessment

	1985 Nonpoint Loads (thousands of lbs)		Year 1994 Reported Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
King George County	244	24	208	-15%	18	-23%
Northumberland County	304	30	215	-29%	16	-47%
Westmoreland County	522	52	368	-29%	20	-61%
Lower Potomac	1,070	106	790	-26%	55	-48%

	1985 Nonpoint Loads (thousands of lbs)		Proposed Regional Strategy (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
King George County	244	24	165	-32%	14	-41%
Northumberland County	304	30	163	-46%	10	-68%
Westmoreland County	522	52	276	-47%	6	-88%
Lower Potomac	1,070	106	604	-44%	30	-72%

Table 6-22. Total Nutrient Loads for Lower Potomac Region

Based on Implementation of Proposed Regional Assessment

	1985 Controllable Loads (thousands of lbs)		Year 1994 Reported Values (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
King George County	249	26	219	-12%	19	-25%
Northumberland County	304	30	215	-29%	16	-47%
Westmoreland County	545	60	394	-28%	27	-55%
Lower Potomac	1,098	115	828	-25%	62	-46%

	1985 Controllable Loads (thousands of lbs)		Proposed Regional Strategy (loads in thousands of lbs)			
	Nitrogen	Phosphorus	Nitrogen	% Change	Phosphorus	% Change
King George County	249	26	193	-23%	16	-40%
Northumberland County	304	30	163	-46%	10	-68%
Westmoreland County	545	60	302	-45%	12	-79%
Lower Potomac	1,098	115	659	-40%	38	-67%

5. Key Point Source Issues Raised During Review of Final Comment Draft

BNR Performance and Wastewater Plant Flow Projections

Some uncertainties exist regarding the expectations for BNR performance and the flow projections for wastewater plants. Estimates of future point source nutrient loads are critically dependent on these two values, along with the total days of operation, to calculate an annualized nutrient load figure. Any conclusion reached about which treatment technology is needed to meet the goal leads to corresponding cost figures for installation, operation and maintenance.

DEQ has relied on several references (primarily the 1991 Chesapeake Bay Program Reevaluation Report #7, "Effectiveness of Point Source Technologies") to define the annual average total nitrogen (TN) effluent levels expected from three types of nutrient reduction systems. They are: seasonal (designed to operate effectively in spring - summer) biological nutrient removal (BNR) = 12 mg/l; year round BNR = 7 mg/l; limit of technology = 3 mg/l. Another option, recently proposed by the Virginia Association of Municipal Wastewater Agencies (VAMWA), is to construct seasonal BNR but operate it year round.

The future wastewater treatment plant flow projections used in the Strategy were provided by the plant owners (in some cases, 3 to 5 years ago) or taken from permit design capacities. The total plant flow projection for the year 2000 that has been used is 285 million gallons per day (M.D.). Using this flow projection, DEQ estimated that the baseline Potomac point source load would be reduced by about 40% if the annual average TN equaled 7 mg/l, which coincides with the performance expected from year round BNR.

The VAMWA Nutrient Position Paper (discussed in Section VII) endorses the use of seasonal BNR with the intention of actually operating the system throughout the year to yield an annual average effluent target of 8 mg/l. This might lead to the conclusion that the VAMWA proposal would not achieve the 40% reduction goal. However, with updated flow information from some plant owners, and after examining the long term flow trends (1985-1995), it is apparent that the flow projections used during the Strategy development process were over-estimated. DEQ now estimates that the year 2000 flow projection should be in the range of about 230 to 260 M.D.. Therefore, based upon these updated flow projections, 8 mg/l effluent nitrogen should be the initial target for implementing this Strategy.

Despite the uncertainties regarding the flow trends and plant performances, there is one clear finding that comes from this effort to more accurately estimate future nutrient loads. **All the point sources involved in the Potomac Strategy must monitor for total nitrogen and total phosphorus in their discharge to enable progress reporting and tracking**. All of the facilities report monthly average flow under their discharge permit provisions. Many of the larger plants already report nutrient values in their discharge monitoring reports to the state, but similar analysis must be done (either through an acceptable voluntary program or a permit condition) at all other plants. The details of this monitoring can be fairly easily worked out, probably resulting in a program closely resembling

the Voluntary Nutrient Monitoring Program instituted by the state in 1987 to measure the effects of the phosphate detergent ban.

Upper Occoquan Sewage Authority (UOSA) Water Reclamation Plant

The October 1996 draft Strategy recommended BNR retrofits at the Northern Virginia Region plants. However, one caveat appearing with this recommendation was the need to examine the applicability of using BNR at the Upper Occoquan Sewage Authority's (UOSA) wastewater reclamation plant. During the assessment phase, UOSA staff informed the state technical assistance team about concerns for protecting the drinking water reservoir that receives the UOSA discharge, and the adverse impacts on plant performance if denitrification were used to remove nitrogen. Further, UOSA representatives offered to submit data that would show that a significant amount of the plant's nutrient discharge is trapped or denitrified in the reservoir, and never reaches the Potomac.

In a July 1996 letter to the Virginia Secretary of Natural Resources, the Chairman of the UOSA Board of Directors wrote:

> "Very stringent nitrogen and phosphorus limits are necessary to protect the Occoquan Reservoir. The phosphorus limit is 0.1 mg/L and UOSA routinely averages about 0.03 mg/L. The nitrogen limit is 1.0 (mg/L) Total Kjeldahl Nitrogen and UOSA routinely meets this standard by nitrification. UOSA does not denitrify because nitrates are very beneficial to the biological balance of the Reservoir by serving as a source of oxygen to prevent the hypolimnion from becoming anaerobic. Under anaerobic conditions, phosphorus is released from sediments which can result in eutrophication and severe water quality problems. Of course, consumption of the oxygen in the nitrates results in denitrification in the Reservoir and, based on the data of the Occoquan Watershed Monitoring Laboratory, 42 percent of the total nitrogen entering the Reservoir is removed annually.
>
> "Denitrification in the UOSA plant would be devastating to the plant processes. Chemical treatment processes at UOSA are used to destroy pathogens, meet the very stringent phosphorus limits, and remove a variety of other pollutants. A denitrified water would increase chemical usage 150-200 percent, produce a similar increase in chemical sludges, and result in much poorer quality water to be treated in the Multimedia Filtration and Activated Carbon Adsorption Systems. The overall impact would be a substantial increase in costs and a deterioration in the quality of the UOSA discharge to the Occoquan Reservoir."

Up to this point, the Strategy's nutrient load estimates for the Potomac assumed that all of the discharged nitrogen and phosphorus from UOSA's plant reached the tidal tributary. If UOSA's claim was correct, then a "delivery factor" should apply to the discharge, accounting for the reduced nutrient load that actually leaves the reservoir.

Documentation has been submitted to the state that further details the significance of UOSA's concerns. The primary document used in the review of these issues was a June 1994 report, "U.S.

EPA Clean Lakes Report for the Occoquan Watershed" (submitted by NOVA PDC for the Occoquan Watershed Policy Board). Several meetings were held with staff from the Occoquan Lab, UOSA, EPA, and DEQ to hear technical presentations on monitoring data and plant operations. The materials provided by UOSA credibly support the contentions that the nitrified effluent has a beneficial impact on reservoir water quality, and that operating a BNR process would likely cause serious problems in the plant (increased chemical usage, scaling in pipes and reactors, leading to a deterioration of effluent quality). It has been concluded that retrofitting UOSA with BNR as a component of the Strategy is not an appropriate measure to take at this time.

However, it should be noted that the plant's discharge permit is being reissued, and contains a condition requiring UOSA to provide nitrogen removal facilities. Operation of this system is required when the reservoir's ambient nitrate concentration is 5 mg/l or greater in the vicinity of the Fairfax County Water Authority intake point. Outside of the permit provisions, UOSA management has also agreed to perform studies that will further investigate the effect that operating BNR will have on the reservoir and the UOSA plant. The study plan will be jointly developed by UOSA, DEQ, and EPA, and will be performed during this permit term.

The Occoquan Clean Lakes report estimated the nutrient reduction achieved in the reservoir. Based on monitoring data from 1983-1991, comparing the total input load (nonpoint source, point source, atmospheric deposition) to all reservoir outputs shows that nitrogen and phosphorus are reduced by about 42% and 56%, respectively. UOSA intends to further assess these "delivery factors," to see what impact Fairfax's water withdrawal has on these values, and to determine if the nitrogen from the plant (virtually all in the form of nitrate) is acted on differently from the nitrogen entering the reservoir via nonpoint source runoff (predominately ammonia and organic nitrogen) which may result in a further decrease of the UOSA delivered load. This issue will be tracked over time, with interaction of the appropriate technical subcommittees of the Chesapeake Bay Program. This is necessary because decisions about the delivered load from this plant will affect the values used for the baseline loads, progress to date, and future forecasts.

Luray STP

This plant receives about 60% of its influent flow from an industrial facility producing denim garments. Due to the industrial wastewater's characteristics, the Luray STP flow is actually nutrient deficient and the operator must add nitrogen and phosphorus to make the biological treatment system function. Therefore, the use of default effluent values for nitrogen and phosphorus concentrations was incorrect when estimating the plant's discharged and delivered loads. The fact sheet for Luray STP in the Southern Shenandoah assessment (Appendix H) shows the owner's corrections for the nutrient levels. This issue must be further assessed and revisions made to the load figures for this plant, with interaction of the appropriate technical subcommittees of the Chesapeake Bay Program. This is necessary because decisions about the delivered load from this plant will affect the values used for the baseline loads, progress to date, and future forecasts.

6. Summary of Regional Assessment Nutrient Reductions

Table 6-23 presents the nonpoint source nutrient reduction practices identified for the Shenandoah-Potomac basin. This list contains no additional practices beyond the sum of the four regional assessments until such time as any additional nutrient reductions achieved through the Agricultural Stewardship Act or other programs can be quantified.

If the full suite of nutrient reduction practices identified in the four regional assessments are implemented, Virginia's Shenandoah and Potomac River basins will have achieved a 37% reduction of nitrogen and 36% reduction of phosphorous in the 1985 controllable annual loadings (Table 6-23). This will leave Virginia short of the 40% reduction goal by an annual loading of 568 thousand pounds of nitrogen and 81 thousand pounds of phosphorus. Table 6-24 presents these loading and reduction figures for each region and for the basin as a whole.

The sum of nutrient reductions outlined in the Shenandoah and Potomac basins regional assessments does not reach the 40% reduction goal for the basin. As a result, additional options are presented in Section B for closing the remaining 3% and 4% nutrient gaps for nitrogen and phosphorus, respectively.

Table 6-23. Nonpoint Source Nutrient Reduction for Virginia's Shenandoah-Potomac Basin

Based on Implementation of Proposed Regional Assessments

		Total Proposed Coverage		Reductions (lbs/year)		Increased Ac	Added Reductions Ach'd	
BMP Treatment	units	Coverage	Percent	Nitrogen	Phosphorus	of Coverage	Nitrogen	Phosphorus
Conservation Tillage	acres	195,933	73.5%	172,449	15,805	14,171	72,951	6,630
Farm Plans	acres	423,276	66.8%	248,764	68,337	52,388	14,979	5,389
Nutrient Management	acres	429,187	59.9%	1,207,809	168,799	243,950	570,293	81,131
Highly Erodible Land Retirement	acres	27,445	2.2%	282,530	45,165	7,786	98,766	13,967
Grazing Land Protection	acres	65,964	10.8%	190,187	12,821	48,196	139,878	9,213
Stream Protection	acres	3,998	-----	5,934	434	1,679	2,533	181
Stream Fencing	linear feet	387,641	-----	12,301	3,648	112,200	3,597	1,056
Stream Protection	linear feet	32,000	-----	11,235	4,932	8,400	2,803	1,283
Cover Crops	acres	45,699	-----	205,411	17,934	818	5,862	442
Grass Filter Strips	acres	2,013	-----	20,932	2,571	1,347	13,950	1,692
Woodland Buffer Filter Area	acres	1,586	-----	32,981	4,641	1,539	32,205	4,512
Forest Harvesting	acres	18,607	100.0%	242,543	5,841	0	0	0
Animal Waste Control Facilities	systems	1,141	-----	593,582	128,264	77	49,738	11,092
Loafing Lot Management	systems	59	-----	9,348	2,058	6	911	210
Erosion & Sediment Control	acres	8,059	100.0%	100,984	51,146	0	0	0
Urban SWM/BMP Retrofits	acres	4,356	1.5%	10,449	1,141	1,156	2,772	303
Urban Nutrient Management	acres	8,553	12.3%	12,605	1,141	3,754	5,698	512
Septic Pumping	systems	167	-----	38,923	0	0	0	0
Shoreline Erosion Protection	linear feet	22,301	-----	60,540	39,453	0	0	0
Total Pounds Reduced:				3,459,509	574,129		1,016,936	137,612
Adjustment for Land Use Changes:				(449,858)	(33,345)			
Adjustment for Poultry Growth:				47,630	10,681			
Adjusted Reduction:				3,861,736	596,793			
Nonpoint Controllable Amount:				10,343,159	1,556,300			
Percent Reduction:				37.34%	38.35%			

Table 6-24. Total Nutrient Loads for Virginia's Potomac River Basin by Source Category

Based on Implementation of Proposed Regional Assessments

	Point Source				Nonpoint Source				Total			
	Nitrogen	% Change	Phosphorus	% Change	Nitrogen	% Change	Phosphorus	% Change	Nitrogen	% Change	Phosphorus	% Change
S.Shenandoah	773	-19%	221	-32%	1,570	-50%	346	-44%	2,343	-43%	567	-40%
N.Shenandoah	684	-24%	96	-32%	847	-54%	157	-44%	1,531	-44%	253	-40%

N.Virginia	4,832	-41%	78	-23%	3,461	-20%	426	-23%	8,292	-34%	504	-23%
Lower Potomac	55	+92%	8	-21%	604	-44%	30	-72%	659	-40%	38	-67%
VA Potomac	6,344	-37%	403	-30%	6,481	-37%	960	-38%	12,825	-37%	1,362	-36%

B. Opportunities and Approach to Closing the Remaining Nutrient Gap

Additional Nonpoint-Source Reductions

In the nonpoint source arena, there exists a wide variety of options for achieving additional nutrient reductions in the Shenandoah-Potomac basin. It is expected that many farmers in the basin will continue to implement agricultural nonpoint source control practices, even without cost-share funds, as they learn of the value of these practices from farmers who participate in Virginia's agricultural BMP cost-share program. This "demonstration effect" was identified through a survey conducted by the Virginia Department of Conservation and Recreation which showed that a much greater number of Virginia farmers implement some form of nonpoint source control practice, as compared to the number who receive cost-share funding for BMP practices (estimated ratio of 2:1, respectively). These data appear to indicate that farmers see the operational and economic benefits of these practices, as demonstrated by their neighbors who implement the practice through the cost-share program, and decide to implement the practice themselves even if they don't participate in the cost-share program.

The ratio of non-cost-share nutrient control practices to cost-share BMPs would likely decrease under an enhanced cost-share system. However, a certain segment of farmers choose not to become directly involved with the cost-share program because of personal preferences. Therefore, the demonstration effect could still apply to these farmers and could lead to the voluntary implementation of additional agricultural control practices outside of the cost-share program. Through continued coordination with soil and water conservation districts across the basin, the Commonwealth will strive to document and credit these activities where possible.

Potential Nutrient Reductions Under Virginia's Agricultural Stewardship Act

Virginia's Agricultural Stewardship Act (ASA - *Virginia Code, Section 10.1-559.1.*) is the product of the joint efforts of the agricultural community, environmental groups, state agencies, and the Virginia's soil and water conservation districts. These groups are currently working with the Virginia Department of Agriculture and Consumer Services to flesh out the ASA program, which is slated to be implemented on April 1, 1997.

The purpose of the ASA is to alert agricultural producers, who are not subject to a permit from the State Water Control Board, to aspects of their operations that are causing, or will cause, water pollution. Investigations under the ASA will be initiated through complaints to the Commissioner of Agriculture and Consumer Services. Upon receipt of a complaint, either the Commissioner or the local soil and water conservation district will investigate to determine whether the activity in question is causing or will cause sediment, nutrient or toxin pollution in the water.

Upon a determination that the agricultural activity is causing or will cause water pollution, the producer will be asked to develop a plan to correct the problem and then to implement the plan over a period of time. These plans are to contain BMPs or other measures that will eliminate the pollution. If the producer does not develop a plan, or if the producer develops a plan, but fails to implement

it, then enforcement action can be taken against the producer.

As with any new program, there are no means of predicting the size of the contribution that the ASA may make to reducing nutrient loadings. From the experience of the other states with similar programs, approximately 200 to 300 complaints per year can be expected for the entire state. These other states have found that the complaints usually involve erosion problems and animal waste practices, so the ASA will potentially play a role in reducing nutrient loadings. The ASA requires that the Commissioner prepare an annual report, summarizing actions taken under the ASA, which may provide a basis for estimating the nutrient reduction impacts in the future.

Urban and Suburban Nonpoint Source Nutrient Reductions

Throughout the Strategy process, many participants expressed the viewpoint that major nutrient loading to the Potomac River occurs as a result of urban runoff, in particular runoff from fertilized lawns in residential areas. These participants stated that this nutrient source must be addressed effectively before nutrient loads in the basin can be truly minimized.

Reducing the use of fertilizer, and the associated nutrient runoff, from lawns in residential areas is addressed through technical assistance programs of the Virginia Department of Conservation and Recreation, and the Virginia Cooperative Extension Service. These programs are valuable because they educate homeowners on how to reduce nutrient pollution at the source. Due to the large number of single-family homes in the Potomac drainage basin, there are continued opportunities for providing homeowners with this information in order to reduce nutrient runoff.

The problem of managing nonpoint source runoff from developing lands and urban landscapes is addressed in Virginia through a number of programs, including Erosion and Sediment Control, Stormwater Management, the Chesapeake Bay Preservation Act, and related technical assistance. One of the principal types of management practices implemented under these programs are urban BMP facilities, such as storm water management ponds. These facilities capture surface water runoff from larger areas and settle out, or otherwise control, nutrients and other types of nonpoint source pollution. These facilities are relatively expensive, when evaluated solely on the basis of pounds of nutrient reduced. However, it is important to note that these facilities provide multiple benefits for managing water quality and quantity; and it is likely that their use will continue, and even expand.

These programs have had an important influence on the reduction of nutrient loads in the Shenandoah-Potomac basin. However, in order to achieve equity with the substantial efforts that will be undertaken by Virginia's farmers in the basin, it is recommended that an evaluation be conducted, in cooperation with local governments in the basin, to look at the variety of nutrient-reduction techniques or programs that may be available, particularly with respect to managing residential nutrient loadings. This evaluation could be initiated through a study commission or other type of ad hoc body.

Proposal in October 1996 Draft for Basin-Wide Upgrades to Biological Nutrient Removal

In the October 1996 draft of the *Shenandoah and Potomac River Basins Tributary Nutrient Reduction Strategy*, it was proposed that the remaining 3% and 4% nutrient gaps could be closed by upgrading all "significant" municipal treatment plants (that discharge at least 500,000 gallons per day) in the basin with BNR technology and operating each year-round. This proposal affected twelve plants (ten in the Shenandoah Valley and two in Lower Potomac) that had not been identified for upgrade with a nutrient control technology in the four regional assessments. The October 1996 draft presented cost estimates and nutrient reduction projections associated with these upgrades and noted that they represented a high-cost option, per pound of nutrient reduced.

Two local governments and two sewer authorities that had participated in the Southern Shenandoah assessment, as well as the Virginia Association of Municipal Wastewater Agencies, opposed this proposal. These commentors stated that they had worked voluntarily and cooperatively with the Commonwealth in the assessment process to identify cost-effective and practical nutrient controls that will exceed the Southern Shenandoah region's 40% reduction goal, and that the proposed prescription of BNR for facilities in their region was neither cost-effective nor equitable. These commentors also stated that they were not necessarily opposed to upgrading plants in the region with BNR, but that any reductions achieved through these upgrades would be needed to help maintain the nutrient cap for their region, as future growth leads to increased nutrient loadings.

The basin-wide BNR proposal provided a definitive option for closing the final gap toward Virginia's nutrient reduction goal in the Shenandoah-Potomac basin. Even if these upgrades are achieved and credited to the future cap needs of the Valley, the Chesapeake Bay will benefit from these nutrient reductions. However, this proposal potentially undermines the locally-based, cooperative approach of the regional assessment process. Also, this proposal focuses on high-cost control options years before available funding would likely be targeted to closing the final (and most expensive) nutrient reduction gap.

The cooperative approach of the assessment process is the cornerstone of the Strategy and must be continued. This approach has garnered support for the Strategy and led to the Governor's proposal for funding Strategy elements (the Governor's budget proposal is described in the final section on costs and funding). Through the Governor's funding proposal, the Commonwealth will be pursuing implementation of Strategy elements on a scheduled and prioritized basis. This scheduled approach offers Virginia the opportunity to reserve the least cost-effective elements of the Strategy (final 3% and 4% reduction practices) until the experience we gain in the coming years of Strategy implementation, and possible technological developments, direct us to the most cost-effective methods of closing the final nutrient gap.

Uncertainties in Predicting, Scheduling and Achieving Nutrient Reductions

The approach of maintaining the final gap-closing methods in an reserve status is supported by the many uncertainties that are inherent in predicting, scheduling and achieving nutrient reductions. As noted by numerous commentors, the science of predicting nutrient loads, and the reductions achieved through various control options, is imperfect. Many of these uncertainties, which apply to both point sources and nonpoint sources, will be clarified as Strategy implementation proceeds.

These answers will tell us whether current and planned control options actually exceed the 36-37% nutrient reduction level (and possibly achieve 40% reduction), and where further reductions can be best achieved if needed.

In the point source arena, there are uncertainties as to whether a number of municipal wastewater treatment facilities in the basin will continue to achieve current nitrogen concentration levels as wastewater flows increase. Additionally, as Strategy implementation proceeds there are uncertainties as to the levels of nutrient reduction that will be achieved through the application of BNR technology at wastewater treatment plants throughout the basin. Finally, it is uncertain whether there are significant opportunities for achieving additional point source nutrient reductions through cooperative efforts with industrial facilities, because these opportunities were not fully explored during the limited time of the assessment process. It is planned, as an element of Strategy implementation, that enhanced stream monitoring and expanded point source monitoring, throughout the basin, will answer a number of these uncertainties.

In the nonpoint source arena, there are uncertainties in many areas. There are still questions on the number, type and coverage of agricultural BMPs that are currently implemented outside of Virginia's cost-share program. There are questions as to what future changes may occur in the rate of implementation of non-cost-share agricultural nutrient control practices; and there are uncertainties with regard to the effects that any changes in the agricultural economy may have on the types of BMPs that farmers choose to implement.

There are also questions with regard to current and future implementation of urban nonpoint source BMP retrofits and the nutrient reductions that would occur as a result of these facilities. In particular, the multiple benefits and numerous governmental programs that are associated with these facilities may indicate that there will be continued application and expansion of these facilities.

Finally, there are questions as to what nutrient reductions could be achieved by a comprehensive approach to providing technical assistance and education to homeowners on reducing the residential use of fertilizer.

Strategy for Closing the 3% and 4% Gaps: Reserve Measures with Trading, Continued Process and Evaluation

Closing the final 3% and 4% nutrient gaps toward the 40% reduction goal in the Shenandoah-Potomac basin is a difficult issue. Because the most cost-effective control options have already been targeted for implementation through the regional assessments, only costly control options remain. The comments received on this issue covered a broad spectrum, and its resolution potentially pits region against region in the overall effort to meet the full 40% nutrient reduction goal.

Shenandoah Valley and Lower Potomac localities believe it is not equitable for them to have to shoulder the burden of closing the final gap. However, it is appropriate to maintain these facilities in the Strategy as reserve solutions that can be credited toward the basin-wide gap until those reductions are needed as cap measures in the Shenandoah Valley and Lower Potomac region, and

until more cost-effective measures are identified through technological advancements and/or experience with Strategy implementation.

It is also very important to maintain these facilities under the auspices of the Shenandoah-Potomac Strategy in case future cost-sharing programs are directly linked, through legislative action, to the Strategy. The Commonwealth will continue to work with these localities and facilities to achieve appropriate nutrient reduction solutions and financing solutions. However, under no circumstances will additional nutrient reductions, undertaken by any region that has met its 40% nutrient reduction target, be credited toward basin-wide reduction if those reductions are needed in that region to help maintain the nutrient cap.

Closing the final 3% and 4% gaps must be based on continued coordination with local governments and stakeholders across the basin and must be closely tied to future program reevaluations and legislative decisions on scheduling and funding. As one commentor pointed out, the local/state coordination needed for Strategy implementation does not end with publication of the Strategy document, it begins there.

Strategy for Closing the Final 3% and 4% Gaps

The Commonwealth's approach to closing the final nutrient reduction gap in the Shenandoah-Potomac basin is outlined below. This approach is built on continued reevaluation and cooperation with all stakeholders in the Shenandoah-Potomac Strategy. Therefore, this approach will offer extremely important benefits to the ultimate success of the full Strategy because it will help ensure that the Strategy continues to be a dynamic document that is responsive to expanded citizen involvement, better solutions and improved technologies.

Although this is the final Shenandoah-Potomac Strategy, the Commonwealth continues to welcome input and comments from all Virginians on the ideas and approach presented below for achieving the full 40% nutrient reduction goal. Full implementation of the Strategy is guided by partnership, flexibility and innovation, as well as the availability of financial resources.

Outline for Closing the Final Gap

- Commonwealth's Strategy is to fully meet the 40% nutrient reduction goal.
- Begin implementation of identified, cost-effective control options.
- Maintain basin-wide BNR as a Strategy element.
- Work cooperatively with Shenandoah Valley and Lower Potomac local governments to identify the conditions that could make point source nutrient control upgrades acceptable.
- Guarantee to these local governments (and sewer authorities) that the reductions from any point source nutrient control upgrades that occur at facilities outside of the assessment would only be credited to the basin-wide reduction goal on a reserve basis and could be reclaimed by localities, as needed for maintenance of their nutrient cap.
- Support other nutrient trading systems that enhance nutrient reductions across the basin.
- Work toward a private/public partnership with industrial nutrient sources across the basin,

including evaluating ways to remove any barriers to public funding of privately-owned facility upgrades.

- Evaluate and actively pursue technological advancements in the area of nutrient reduction.
- Work with local governments across the Shenandoah-Potomac basin to promote construction and maintenance of environmentally sound urban BMP facilities and retrofits.
- Evaluate opportunities for expanding technical assistance and educational efforts directed at residential fertilizer use and lawn care practices.
- Work with soil and water conservation districts across the Shenandoah-Potomac basin to document and credit nutrient reductions achieved through implementation of non-cost-share agricultural nonpoint source control practices.
- Support and improve stream and point source monitoring programs.
- Use the annual reporting process of House Bill 1411 as a primary vehicle for ensuring public and legislative involvement in evaluations and decisions.
- Evaluate equity of Strategy implementation on an ongoing basis.
- Continue to evaluate levels of implementation and success of nonpoint source control options, and levels of reductions achieved through point source control options - make course corrections when and where necessary.
- Make final decisions on 3% and 4% gap closing measures, and any appropriate trading mechanisms, by the time the Strategy elements identified in the regional assessments have been funded at a level of 75%.
- Continue to work with local governments across the basin to identify necessary program, staff and funding needs for the development and implementation of "cap" strategies and activities that will prevent future increases in nutrient loads.

Through the HB 1411 reporting process, and continued coordination with the General Assembly, the cooperative Strategy efforts that have been undertaken among citizens, stakeholders and local elected officials in the basin are being expanded to include our state elected officials as well. As the Commonwealth proceeds with Strategy implementation and ongoing reevaluation, this framework will provide an information conduit, from citizens to elected officials and from elected officials to citizens, on important water quality issues in the basin.

To the extent that opportunities for basin-wide implementation of point source nutrient control technologies are realized through continued coordination with Shenandoah Valley and Lower Potomac local governments, the following table represents the total Strategy nutrient reductions. At such time that these reductions are needed in these regions to help maintain the nutrient cap, these reductions will be replaced with other gap-closing options that will be determined in cooperation with stakeholders in the Shenandoah-Potomac basin and the General Assembly, through the annual reporting process of House Bill 1411.

Table 6-25. Total Nutrient Loads for Virginia's Potomac River Basin by Source Category

Based on Proposed Strategy Nutrient Reduction Levels

	Point Source				Nonpoint Source				Total			
	Nitrogen	% Change	Phosphorus	% Change	Nitrogen	% Change	Phosphorus	% Change	Nitrogen	% Change	Phosphorus	% Change
S.Shenandoah	531	-44%	199	-39%	1,570	-50%	346	-44%	2,101	-49%	545	-42%
N.Shenandoah	273	-70%	55	-61%	847	-54%	157	-44%	1,120	-59%	212	-49%
N.Virginia	4,832	-41%	78	-23%	3,461	-20%	426	-23%	8,292	-34%	504	-23%
Lower Potomac	28	-2%	6	-39%	604	-44%	30	-72%	632	-42%	36	-69%
VA Potomac	5,664	-44%	337	-42%	6,481	-37%	960	-38%	12,145	-41%	1,297	-40%

C. Implementing Virginia's Shenandoah and Potomac River Basins Tributary Strategy

Implementing Increased Agricultural Cost-Share Program

The principal nonpoint source program enhancement recommended in the regional assessments to aid in achieving the Potomac River 40% nutrient reduction goal is a substantial increase in the level of cost-share funds available to farmers in the Shenandoah-Potomac basin to plan, design and construct nonpoint source control practices. The implementation of increased cost-share funding can occur through the mechanism that currently exists at the Department of Conservation and Recreation, the Chesapeake Bay Local Assistance Department and the soil and water conservation districts in the basin. Full implementation may require additional staff at DCR who are targeted to this program or additional staff at the local level, as preferred by Shenandoah County and the Lord Fairfax Soil and Water Conservation District. In each of the districts, staff will be needed to administer these new funds, and these staff needs are addressed in each of the regional assessments.

Implementing Point Source Upgrades

Point Source Hierarchy for Nutrient Reduction in the Potomac Basin

Background and Description. Virginia's Shenandoah-Potomac Strategy is based on the Commonwealth's commitment to work in partnership with citizens, farmers, businesses, wastewater treatment plant owners and local governments in the basin to achieve voluntary nutrient reductions.

Although many citizens voiced their support for a nonregulatory approach to nutrient reduction, the majority of these citizens stated that a purely voluntary program will likely not reach the full 40% nutrient reduction goal for the Potomac River. These citizens believe that the voluntary approach should be enhanced so that parties who voluntarily participate in nutrient reductions can be assured that their neighbors and competitors in the basin are also doing their fair share. In particular, as local governments and wastewater treatment plant owners spend money on nutrient reductions, they need to be able to tell their constituents and rate payers that others in the basin are also doing their part to achieve the goal.

The proposed "Point Source Hierarchy" offers three levels of state/local partnership that provide an incentive for participation in the program. It is designed to promote the voluntary, cooperative approach for nutrient reduction and to allow substantial local latitude in achieving nutrient reduction. Level I of the hierarchy, the voluntary, cooperative approach, is the Commonwealth's preferred method.

POINT SOURCE HIERARCHY

LEVEL	APPROACH	DESCRIPTION
I	Voluntary Cooperative	*Enlist treatment plant owners in a voluntary, cooperative nutrient reduction program including an owner-generated plan for selecting and operating a nutrient reduction system for their plant.*
II	Directed Cooperative	*Direct participation through a special condition in the discharge permit. This special condition would call for an owner-generated plan for selecting and operating a nutrient reduction system for their plant. The special condition would not specify nutrient limits in the discharge permit.*
III	Regulatory	*Set nutrient limits in the discharge permit using as much flexibility as regulatory process allows.*

Proposed Implementation Steps. A letter from the Secretary of Natural Resources will be sent to the chief elected governing official of a locality (copy to chief executive), or to the chief official of a private business, if that facility is identified for nutrient control upgrade in a regional assessment. The letter would outline the importance of local initiative in the Commonwealth's Strategy, convey the expectations for local involvement, and offer state technical assistance. If applicable, the letter would also outline any additional criteria that would apply under any state cost-share program.

Dischargers would be invited to select their level of participation in the Strategy. The letter would state that Virginia prefers to work at the Level I approach with local governments and businesses. However, this choice remains a local decision and the Commonwealth will work with the discharger through the approach selected. In the case of local governments, the local decision should be endorsed by, and communicated from, the local governing body to ensure a clear, public understanding of the locality's commitment to participate in the Strategy.

Dischargers that request either Level II or III in the hierarchy would be asking the Commonwealth to set forth a special condition in their discharge permit that requires development of a plan for nutrient reduction or to set specific nutrient effluent limits. No response to the invitation places the discharger into Level II by default.

During implementation of the Strategy, if participation at Level I or II is determined to not be succeeding, the discharger would be placed into the most restrictive hierarchy level, level III. Criteria will need to be established, in consultation with stakeholders, describing acceptable levels of cooperation and compliance with appropriate timelines by which these determinations would be made.

Nutrient Allowance Trading: Creating Incentives for Cost-effectiveness

The regional approach to assessing available nutrient reduction options allowed participants in the process to focus on local issues and needs in the determination of appropriate practices. However, not all of the practices that were identified regionally are necessarily the most cost effective practices, basin-wide, for meeting the 40% nutrient reduction goal. A nutrient trading system could be an effective way to maintain the integrity of the regional approach, while allowing certain nutrient sources to consider cost-saving approaches in other regions, or from other types of nutrient sources. In four meetings held in the Shenandoah and Potomac basins, many participants felt that establishment of a nutrient allowance trading program would be a way to strengthen and reinforce incentives and also create a way to manage future loads under a nutrient cap.

A nutrient allowance trading system creates pollution reduction incentives by granting nutrient dischargers the flexibility to search for lower cost options to achieve required levels of nutrient reductions. Through this type of system, nutrient dischargers (for which nutrient controls would be more expensive) can reduce their costs for achieving nutrient reduction goals. These dischargers would purchase credits, or allowances, from other nutrient sources that can achieve nutrient reductions less expensively. These allowances specify the quantity of nutrients that the "seller" source (for which nutrient controls would be cheaper) has to achieve; and these reductions are then credited against the level of nutrient reductions required of the "buyer" source. The decision to trade is voluntary and sources engage in trade only if both are better off following the trade.

Nutrient trading has been tested in North Carolina, where a nutrient allowance trading system was established as part of a plan to improve water quality in the Tar-Pamlico Basin. In 1991, an association of twelve WWTP (wastewater treatment plants) and one industrial firm accepted a cap on their total, joint discharge of nitrogen and phosphorus. Between 1991 and 1996, the size of the cap was reduced to the current level of 405 thousand kilograms per year. The association allocates responsibility for meeting the cap by assigning nutrient credits to its members. One credit allows the holder to emit one kilogram of nutrients. In event that the total cap is exceeded, the association agreed to pay a $29 discharge fee for every excess kilogram. To date the program has been successful. While the North Carolina Department of Environmental Management oversees program implementation, the program is administered by the association of dischargers outside the conventional permitting system. Association members are taking advantage of the flexibility that allows them to channel dollars to the source that can achieve greatest nutrient reduction for the least cost. Consequently, total nutrient control costs are less than half of the original estimates.

A type of water quality trading is already occurring in Virginia. Recently, CBLAD approved a phosphorus trading system developed by the City of Williamsburg. Developers face a requirement to manage storm water runoff from a development site. Williamsburg plans to construct regional storm water management facilities in developing areas in order to control phosphorus runoff. The phosphorus reduction "credits" from these facilities will then be offered for sale to developers. The developer has the option of either purchasing the required removal requirements from the city's regional bank or providing equivalent control on-site. The plan is expected to generate the greatest

cost-savings for small developments where on-site treatment tends to be very expensive.

These two examples demonstrate how a trading system can be tailored to meet unique local water quality and policy circumstances. Progress toward nutrient allowance trading implementation, however, requires certain basic elements, including the establishment of a cap or limitation on discharges, and a system in which sources can trade nutrient discharge responsibility. Appendix A includes a more detailed description of the conditions for establishing a nutrient allowance trading system.

VII. MEETING THE COSTS OF NUTRIENT REDUCTIONS

Review of Costs

Implementing the Shenandoah-Potomac Tributary Strategy will result in six categories of costs, that arise in both the public and private sectors:

- Costs for planning, design and construction of nonpoint source nutrient control practices.
- Capital costs for controls such as wastewater plant upgrades or conservation tillage equipment.
- Annual operation and maintenance outlays for equipment, labor and materials necessary to limit discharge. These costs might be for the use of capital equipment or annually recurring expenses such as soil and manure testing.
- Effects on profits from practices necessary to limit discharge. For example, there may be a reduction (or increase) in crop yields due to a nutrient control practice.
- Administrative and legal costs for dischargers to comply with a regulation or incentive program. For example, a farm land owner may have to demonstrate that implementation of a control practice on his land warrants cost-share funding.
- Public agency costs for education and technical assistance, to administer financial incentives and to develop and enforce requirements for discharge reduction. These include expenses for staff, data gathering and verification (e.g., water quality monitoring), technical and modeling analyses, defining and enforcing program rules, and tracking results.

The costs for practices, as reported in the assessments, may not fully detail all the cost categories listed above. For example, only capital costs may be included for some practices. The regional assessment process identified the need for increased data, monitoring and modeling in order to better judge progress, target cost-share funds and support use of nutrient trading. However, modeling and monitoring costs are not part of the cost estimates. Also, costs for some practices (including BNR) can be site-specific and can vary over a wide range.

The agencies developing the Strategy were well aware of these limitations and pointed them out in the written materials. Unfortunately there are no readily available alternative estimates of some costs. However, no matter how refined the cost estimates are, they must be seen as best approximations. Experience has shown that actual costs can differ significantly from estimates once nutrient control operations begin, and the "cost reducing discovery process" starts.

Costs of the Shenandoah-Potomac Nutrient Reduction Strategy

The cost figures that came from the regional assessment process are presented in Table 7.1. The figures for wastewater plant modifications are presented as a range, because of the potential for lower estimates coming out of plant-specific BNR retrofit analyses and owner-generated updates prepared under the VAMWA proposal (detailed later in this section). Also, the point source capital

costs are dependent on the type of technology being installed, and the state has used estimating methods associated with the use of year round BNR, while the VAMWA figures assume the use of seasonal BNR. Despite these variations, the state's and VAMWA's total cost figures for the Northern Virginia plant retrofits are in fairly close agreement, although there are some offsetting differences from plant to plant. It must also be noted that the point source retrofit costs are planning level and are generally known as "order of magnitude" costs, considered to be accurate within plus 50% or minus 30%.

Table 7-1. Cost to Install Controls Recommended in Regional Assessments

Region	Installation Cost for Controls		
	Nonpoint Source	Point Source	Total
Southern Shenandoah	$5,960,000	$50,000	$6,010,000
Northern Shenandoah	$2,500,500	$570,000 - $2,850,000	$3,070,500 - $5,350,500
Northern Virginia	$1,530,000	$84,220,000 - $87,030,000	$85,750,000 - $88,560,000
Lower Potomac	$490,000	$0	$490,000
Total	$10,480,500	$84,840,000 - $89,930,000	$95,320,500 - $100,410,500

In addition to the wastewater treatment plants recommended in the regional assessments for retrofit with nutrient removal systems, there are twelve facilities in the Shenandoah and lower Potomac regions that may be future candidates for retrofit. The total capital cost to add nutrient removal capabilities at these plants ranges from $33.6 to $66.9 million dollars. A range is shown because in some cases lower estimates have been developed under the BNR retrofit study being conducted by Dr. Clifford Randall of VPI&SU. Also, several of these plants are currently achieving nitrogen removal levels equal to, or better than, BNR treatment levels and may not be appropriate for retrofit if this performance can be maintained. The potential exists for these costs to become part of the expense for strategy implementation, perhaps as a "capping" measure in a region or to assist in achieving the basin-wide nutrient reduction goal.

The estimated additional **administrative costs** for the local and state agencies that would manage the proposed nonpoint source control programs totals $320 thousand per year. These costs are related primarily to staffing needs for technical assistance and grants administration. The regional assessments identified the need for eight additional staff, working at the local level, to function as nutrient management specialists (agricultural and urban), farm plan writers and BMP implementation specialists. Disbursement of funds and contract management for point source retrofit projects would be accomplished through the existing Revolving Loan Fund program structure. Therefore, no additional administrative costs are foreseen for this component of the Strategy.

Financial Assistance Available for Strategy Implementation

There are many ongoing programs within the Commonwealth that provide financial support for nutrient reduction efforts, and the Strategy assumes their continued availability at current funding levels. These programs include:

Agricultural Best Management Practice (BMP) Cost-Share Program - Virginia's Agricultural BMP Cost-Share Program is administered by the Department of Conservation and Recreation (DCR) to improve water quality in the state's streams and rivers and the Chesapeake Bay. Its goal is to encourage voluntary installation of agricultural BMPs that will reduce nonpoint source pollution. These include reducing the input of nitrogen and phosphorus to nutrient enriched waters. The cost-share program currently supports funding for 22 separate conservation practices. Some practices are paid at a per-acre rate for utilization while others are cost-shared on a percentage basis up to 75%, with upper limits on the total amount a grantee can receive under the program for certain BMPs. The program is currently funded at an annual rate of $1.048 million and is implemented by the DCR through Virginia's local soil and water conservation districts within the Bay watershed.

Local Tributary Strategy Support by Soil and Water Conservation Districts (SWCDs) - For each year of the current biennium, the General Assembly allocated $280 thousand for tributary strategy coordination and implementation activities conducted by SWCDs in Virginia's Chesapeake Bay watershed. Projects in the Potomac Basin are slated to receive $95 thousand this year, and $40 thousand next year. The SWCDs in each Tributary basin are working together to develop projects that demonstrate and promote land management techniques suitable for widespread use.

Tax Credit for Installing Agricultural Best Management Practices (BMPs) - The 1996 General Assembly passed legislation (*Virginia Code sections 58.1-339.3 and -439.5*) that provides tax credit for BMP installation costs. The allowance goes into effect January 1998, and permits an individual or corporation involved in agricultural production for market, who has a soil conservation plan approved by the local SWCD, to take a tax credit equal to 25% of the first $70 thousand that they spend for BMPs. Eligible practices are listed in the DCR publication, *"Agricultural BMP Implementation Manual"*, and include livestock and poultry waste management, soil erosion control, nutrient and sediment filtration and detention, and nutrient management.

Virginia Revolving Loan Fund - Over the past 8 years, the Commonwealth has made an efficient and effective transition from offering grants for the construction of publicly owned wastewater treatment and conveyance systems to providing loans for these local wastewater treatment improvements needs. Virginia has invested over $60 million, coupled with over $325 million in federal funds, to help capitalize the Virginia "Wastewater" Revolving Loan Fund (VRLF) for this purpose. In its first eight years, the VRLF program has closed 100 loans with Virginia's localities ($412.5 million), with loans to 20 more localities currently awaiting approval ($62.3 million). Localities receive financial benefits from this program in several ways, since the state's wastewater loan program absorbs the typical up-front costs to secure and close the loan, such as the loan origination fees and service charges and provides the loan at low-interest rates. The VRLF's ceiling interest rate is reviewed and maintained at one percent (1%) below the current municipal market interest rate for a 20-year AA rate revenue bond issue. The program also provides lower interest loans, decreasing to zero percent (0%) based on project type and the financial impact of

borrowing money on the residential users of the system. Congress is expected to continue the revolving loan capitalization process, providing an estimated $30 million of federal funds to Virginia per year through 2002, to further capitalize the VRLF program. The state is obligated to provide a 20% match for the federal funds received. With approximately $25 to $30 million per year in revenue from repayments coming back to the VRLF from existing loans, about $60 to 65 million per year should be available to support the sewer related needs of Virginia localities through the year 2002. Once the program is fully capitalized, in 2002, the VRLF's repayment stream to perpetuate its financing programs should continue in the neighborhood of $45 to $50 million per year.

Virginia Coastal Resources Management Program (VCRMP) - Protection and enhancement of coastal resources is accomplished under the VCRMP, which received federal approval from the National Oceanic and Atmospheric Administration in 1986. Virginia receives federal funds to implement the program within the coastal zone (tidewater cities, counties, and towns and all waters therein, out to the 3-mile territorial sea boundary) and to require that federal actions within the coastal zone be consistent with the state's program. The VCRMP is an effective intergovernmental partnership between state agencies and local governments, and relies on a network of state and local laws, regulations, and policies. Support for tributary strategy development has been a VCRMP component since 1995, when it was made a top priority for use of the program's competitive implementation grant funds. Early in each calendar year a request for proposals is distributed to state agencies and coastal area local governments. In 1996 the state received nearly $2.63 million in federal funds for the VCRMP. About 30% of this amount ($677,400) was awarded under 50/50 cost-share grants to local governments and planning district commissions for tasks under the core program elements, which included several projects directly related to tributary strategy development. This funding level is expected to continue for the foreseeable future.

Chesapeake Bay Preservation Act - The Chesapeake Bay Local Assistance Department (CBLAD) provides assistance to 84 Tidewater local governments for implementing the Chesapeake Bay Preservation Act of 1988. Financial support is also extended to the Tidewater planning districts and local soil and water conservation districts. CBLAD's Competitive Grants Program is the agency's primary financial assistance program. CBLAD has strived to establish a grants program that is equitable and cost-effective while meeting local needs directly. The grants program is designed to promote regional cooperation and broadly applicable, innovative local approaches to protecting water quality, thereby deriving economies of scale. Grant recipients are required to provide a 50% match. The annual funding available for the grants program is approximately $725 thousand, and the average number of projects supported is about 40. The grants program emphasizes local projects that assist in program development or implementation. While there has been consistent funding since the beginning of the program, local funding was reduced by $20 thousand last year by the General Assembly and continued support at current levels is uncertain as localities complete adoption of local Bay Act ordinances and programs.

A second element of CBLAD's financial assistance program is Agricultural Water Quality Planning, which supports local government implementation of the program's regulatory requirements for farm land. In the 1994-96 biennium, $375 thousand per year in state funds was appropriated to Tidewater soil and water conservation districts to develop conservation plans for agricultural activities in

Chesapeake Bay Preservation Areas. Typically, 10 to 12 district staff are supported by these funds. This funding has remained constant and appears likely to continue at current levels.

A portion of CBLAD's annual funding to aid localities is discretionary, and supports technical assistance to localities. These funds are used for the development and distribution of educational materials and for special projects, typically computer hardware, software, and applications. On average, three to four projects are funded per year in this manner.

Federal 1996 Farm Bill - In addition to these state-administered programs, the 1996 Farm Bill has provisions for funding assistance to build on the conservation gains made by landowners over the past decade. The Bill simplifies existing programs and creates some new ones to address high priority environmental protection goals. The new Environmental Quality Incentives Program (EQIP) consolidates four programs into one and focuses assistance on locally-identified priority areas where agricultural improvements will help meet water quality goals. Projects within Virginia may receive $1.6 million under EQIP this year, and it is likely that half will be dedicated to conservation associated with livestock operations. The amount of future funding targeted to Virginia under EQIP is currently under review, although it is expected to continue at or above the amount previously authorized. Other elements of the Farm Bill that may offer financial relief include the Wetlands and Conservation Reserve Programs, Farmland Protection Program, Swampbuster and wetlands provisions modifications, and Wildlife Habitat Incentives.

Financing Recommendations for Strategy Implementation

In regional discussions and survey responses, **the greatest preference was expressed for intergovernmental transfer of funds**, earmarked for measures such as point source retrofits or nonpoint source control practices. The regional assessments done in the mostly agricultural or rural regions identified nonpoint source controls that could be enhanced and expanded, but the load reductions to be achieved are dependent on increased BMP cost-share support (i.e., total amount available, percentage awarded, and raising or eliminating caps). In the urbanized regions, and areas with significant point source discharges, a financing option frequently mentioned was the July 1996 draft position paper from the Virginia Association of Municipal Wastewater Agencies (VAMWA). This paper is now an official VAMWA position (formally adopted October 3, 1996), and through this position VAMWA seeks several commitments from the Commonwealth, most notably:

- At least 50% grant funding for systems that remove nutrients. The position paper recommends that the General Assembly create a joint study committee to identify new sources of funding for the grant program.
- Implementation through agreement, not by permit.
- Future nutrient cap controls based on equity and sound science.

In consideration of these views, and noting the state's commitment to work towards the nutrient reduction goal in partnership with local governments and stakeholders, Governor Allen recently announced his administration's proposal to aid in financing the Strategy. This set of initiatives targeted at restoring the Chesapeake Bay includes $11 million to implement the Shenandoah and Potomac Strategy, $8 million to assist with improvements to municipal wastewater

plants throughout the state, and a new, voluntary Bay tax check-off. Funds would be disbursed from a new Chesapeake Bay Tributaries Restoration Trust Fund as a 50% match for projects that reduce the flow of nutrients into the Bay within the Potomac and Shenandoah watersheds.

Projects assisted by the Fund may include:

- $1.6 million for Blue Plains sewage treatment plant, serving Northern Virginians
- $200,000 for Stafford County's Aquia wastewater plant, now operating in BNR mode
- $5 million for other Northern Virginia treatment plants
- $2.5 million for early planning and design work for upgrades to other plants
- $1.5 million to implement additional agricultural best management practices, including costs for planning and facility design.

To receive funding, projects must fall into one of four basic categories: 1) upgrading municipal sewage treatment plants; 2) improving storm water management in urban and rural areas; 3) implementing erosion and sediment controls; and 4) expanding nutrient management practices.

Also targeted at improving water quality, the Governor's initiative adds $8 million in new state funding to about $800 thousand in accumulated interest earnings to Virginia's Wastewater Revolving Loan Fund. The funds will leverage $44 million in federal funds over the next biennium, making a total of $52 million available for low-interest loans for local improvements to sewage treatment plants.

It has been acknowledged that this initial investment in the new Chesapeake Bay Tributaries Restoration Trust Fund must be followed by continued funding in order to address the costs of the Shenandoah and Potomac Strategy, as well as strategies yet to be developed for the remaining Virginia Bay tributaries. With a tax form check-off, available for use when reporting 1997 earnings, it is hoped that a significant amount of voluntary pledges will be made to invest in the restoration and protection of Chesapeake Bay and its Virginia tributaries.

Schedule of Implementation

The time needed to fully implement the recommended nutrient reduction controls is largely dependent on the timing and availability of local and state financing. The schedule will also be influenced by the time needed to plan, design, and construct point source retrofits. It is important to note that certain plants in the Shenandoah-Potomac basin have already undertaken significant planning and design activities related to nutrient reduction and other plant improvements.

Innovations and Future Technology Advances

As implementation of the Shenandoah-Potomac Strategy proceeds as a result of any action taken by the General Assembly, future advances in technology or innovations in program design may provide improved efficiencies and/or lower costs for nutrient controls. During this initial implementation period, the Commonwealth's agencies will consider any and all such advances and

innovations to ensure that the 40% nutrient reduction goal is achieved as cost effectively as possible. Citizens, stakeholders and local officials throughout the Shenandoah and Potomac River basins are encouraged to continue searching for improved ways to reduce nutrient loads and to revise the types of practices that have been identified through the assessment process.

GLOSSARY

Animal Confinement Runoff Management: This best management practice includes the use of roof runoff control, diversions, grass filters, etc. to reduce nutrient loss from water flowing through animal confinement operations.

Anoxia: The absense of oxygen within an ecosystem. Within the context of the Chesapeake Bay Program, it is when oxygen is measured at a concentration level of zero miligrams per liter (0 mg/l).

Benthic Communities: Organisms such as worms, insects, and some shellfish that live within and at the surface of the sediment at the bottom of the river. The ecological role of these organisms is complex and important. It includes controlling the degradation and processing of living and dead organic material in the sediment and serving as an essential link in the "food web" which supports higher levels of life.

Best Management Practice (BMP): A practice or combination of practices that are determined to be the most effective and practical (including technological, economic, and institutional considerations) means of controlling point and nonpoint pollutant levels compatible with environmental quality goals.

Biological Nutrient Removal (BNR): A modified form of activated sludge wastewater treatment that enhances phosphorus and nitrogen removal by microbial organisms instead of traditional chemical addition systems. For the purpose of this Strategy, BNR is described as a "3-stage system," using a sequence of anaerobic-anoxic-aerobic reactor basins. Increased phosphorus removal is accomplished by creating environmental conditions that encourage the biomass to accumulate increased quantities of phosphorus, which are then settled and removed in the waste sludge. Nitrogen removal occurs because nitrate-nitrogen contained in the recycle stream is converted to nitrogen gas in this process and released to the atmosphere.

Biomass: The total mass of living matter within a given volume of an environment.

Chlorophyll: A compound present in all green plants used for the conversion of sunlight into useful biochemical energy. Chlorophyll is often used to measure the amount of phytoplankton biomass in water. Excess amounts of chlorophyll indicate high amounts of phytoplankton.

Conservation Tillage: Any tillage or planting system that leaves at least 30% of the soil surface covered with crop residue after planting. Examples are no-till, ridge tillage, strip tillage, etc.

Controllable Nutrient Load: It represents the portion of the total nutrient loads caused by human activities rather than those loads attributable to natural processes.

Conventional Tillage: Complete inversion of the soil incorporating all residues with a moldboard plow, or any practice that leaves less than 30% residue on the soil surface.

Cover Crops: Crops, such as rye, wheat or barley, that are planted without fertilizer in the early fall in order to trap leftover nitrogen so it will not leach into the soil and groundwater. These crops also reduces winter time erosion of the soil.

Dissolved Oxygen: An essential element for the survival of aerobic organisms. Oxygen becomes dissolved into water through diffusion from the atmosphere or surface agitation (i.e., waves). In bottom waters farthest away from the surface, dissolved oxygen can be consumed by aquatic organisms at a faster rate than it is supplied. This can lead to hypoxia (oxygen concentration levels less than 2 mg/1) or anoxia (0 mg/l). Hypoxic or anoxic conditions lead to the death of aquatic organisms and/or the loss of useful habitat.

Erosion & Sediment Control Measures: The use of various best management practices such as silt fences, sediment basins, check dams, diversions, etc. to reduce sediment and nutrient runoff during construction activities associated with land development.

Eutrophication: A natural process of "aging" of water bodies caused by increasing nutrient availability and cycling. This process is greatly accelerated by anthropogenic (i.e., human caused) inputs of nutrients. When abnormally accelerated, negative ecological impacts such as anoxia and instabilities in biological communities occur. Ecological measurements to track impacts of eutrophication include measurements of nutrient concentrations, water clarity, dissolved oxygen and those biological communities most directly linked to nutrient enrichment impacts (e.g., benthic, phytoplankton, zooplankton).

Farm Plans (also known as Soil and Water Quality Conservation Plans): For the purposes of the Chesapeake Bay watershed model, a resource management system for a farm consisting of soil conservation erosion controls for cropland. These controls may include contour farming, strip-cropping, terraces, cover crops, grassed waterways, filter strips, diversions, and sediment-retention or water-control structures. Farm plans do not include conservation tillage or nutrient management which are covered in other Chesapeake Bay Watershed Model BMP categories.

Fertilizer: Any organic or inorganic material, natural or synthetic in origin, that is added to a soil to supply elements essential to plant growth. This includes commercial compounds, manure, and sewage sludge.

Forested and/or Grassed Buffers: Vegetative buffers, typically 50 to 150 feet wide, that are established adjacent to streams and other receiving waters to filter runoff of sediment and nutrients from adjacent land uses.

Forest Harvesting BMPs: The use of erosion & sediment control measures to prevent sediment and nutrient runoff from leaving the immediate area of a forest harvesting activity.

Highly Erodible Land: For the purpose of the Chesapeake Bay Watershed Model, all cropland having an erosion index of greater than eight as reported to the Chesapeake Bay Program Office by the Soil Conservation Service.

Livestock Waste Management: Through the use of storage structures or lagoons to store animal waste, the waste can later be used as a fertilizer source in crop production. This process reduces nutrient loads that would otherwise enter the landscape without an opportunity for further and more efficient plant uptake of the nutrient source.

Limiting Nutrient: The specific nutrient (usually nitrogen or phosphorous in aquatic systems) which controls the rate of phytoplankton growth due to a decreased concentration relative to plant needs and in reference to other nutrients present.

Limits of Technology (LOT): Regarding point source phosphorus removal, LOT usually consists of very elaborate chemical addition and filtering systems placed after secondary wastewater treatment. For point source nitrogen removal, LOT may consist of breakpoint chlorination or a "5-stage" BNR system, using a sequence of anaerobic-dual anoxic-dual aerobic reactor basins. LOT systems are expensive to construct, operate, and maintain. LOT is capable of achieving very low levels of nutrients in effluent, with monthly averages on the order of 3 mg/l total nitrogen, and 0.075 mg/1 total phosphorus. In terms of nonpoint sources, LOT consists of 100% implementation of BMP practices on agricultural, urban and forest lands.

Nitrification: The biochemical oxidation of, or any other natural or artificial process of converting, the ammonium form of nitrogen to its nitrate form.

Nitrogen: An essential nutrient for the growth of living organisms. It is found throughout the environment in particulate and dissolved forms in both living and non-living compounds. It will readily remain in a dissolved form, and, therefore, anthropogenic inputs of this nutrient often occur through groundwater pathways as a result of excess nutrient application. Its main biochemical function is in the formation of amino acids which are the main building blocks for the formation of living biomass.

Nonpoint Source (NPS) Pollution: Diffused pollutants that are washed off the land during the natural process of rainwater flowing accross the land to rivers, lakes, oceans and other water bodies.

Nutrients: Elements or compounds, such as carbon, nitrogen, phosphorous, essential as raw material for the growth and development of plants and animals.

Nutrient Enriched Waters: Surface waters of the Commonwealth, identified by the Water Quality Standards (VR 680-21-07.3), that exhibit the undesirable impacts of excessive inputs of phosphorus and nitrogen. Designations are made by the State Water Control Board based upon an evaluation of historical water quality data for one or more of the following indicators of nutrient enrichment:

chlorophyll levels; dissolved oxygen fluctuations; and concentrations of total phosphorus. In Virginia, the main Bay and all its tidal tributaries are "nutrient enriched waters."

Nutrient Management: A management practice which provides recommendations on optimum nutrient application rates, nutrient application times, and nutrient application methods based on soil and manure analysis results and expected crop yields.

Nutrient Management Plans: A written, site-specific plan indicating how the major plant nutrients (nitrogen, phosphorous, and potassium) are to be managed annually for expected crop production. Nutrient management plans also account for desired crop yields, existing nutrient levels in the soil, application of additional nutrients to maintain optimum soil levels of any particular nutrient, farming practices, and impacts to surface and ground waters.

Pasture: Grazing lands planted primarily with introduced or domesticated native forage species that receive periodic renovation and/or cultural treatments such as tillage, fertilization, mowing, weed control, and irrigation. These lands are not in rotation with crops.

Phosphorus: An essential nutrient for the growth of living organisms. It is found throughout the environment in particulate and dissolved forms in both living and non-living compounds. It will readily adsorb to sediments, and therefore anthropogenic input of this nutrient often occurs though sediment runoff from agricultural activities or bank erosion. Its main biochemical function is in the formation of ATP (Adenosine TriPhosphate), a form of energy storage for cellular metabolism.

Phytoplankton Communities: Small plants, often called "algae," growing within the water column. Phytoplankton produce much of the organic material for the "food web" of the Chesapeake Bay. Changes in the structure and productivity of the phytoplankton community can be caused by eutrophication and can create imbalances in the ecology of aquatic ecosystems.

Point Source (PS) Pollution: Discharges of treated or untreated effluent from industries, wastewater treatment plants and other sources that can traced back to a single point of discharge.

Point Source Policy for Nutrient Enriched Waters (Point Source Policy): This policy (VR 680-14-02: effective 5/25/88) adopted by the State Water Control Board, provides for the control of discharges of nutrients from point sources affecting designated "nutrient enriched waters." It imposes a monthly average total phosphorus effluent limitation, on plants permitted to discharge 1 million gallons per day or more, of 2 milligrams per liter (mg/1). New source dischargers of 50,000 gallons per day or greater (including expansion of existing plants) are required to meet the same limitation.

Potomac Embayment Standards: The monthly average standards of quality for all sewage treatment plant effluents discharging into Virginia's Potomac Embayments from Jones Point (Hunting Creek) to the Route 301 bridge, and for expansions of existing plants discharging into the non-tidal

tributaries of these embayments. These standards are as follows: BOD < 3 mg/1; unoxidized nitrogen < 1 mg/l from April 1 - October 31; total phosphorus ~ 0.2 mg/1; total nitrogen < 1 mg/1 (when technology is available). These standards are undergoing review by the State as a result of enhanced modeling in the area and a petition made to the State Water Control Board by several of the affected localities.

Poultry Waste Management: This measure uses storage sheds in a poultry production operation to stockpile poultry litter from partial cleanouts required after each flock of birds is removed.

Retirement of Highly Erodible Land: Highly erodible lands are taken out of crop production and/or grazing and planted with a permanent vegetative cover such as grasses, shrubs and/or trees. This practice stabilizes the soil and reduces the movement of sediment and nutrients from the land.

Septic System Management: Septic system management includes three specific practices to reduce nutrient losses from septic systems. These are regular pumping of the system, installation of nitrogen removing (i.e., denitrification) components, and bypassing a septic system by connecting to a sanitary sewer. Currently, regular pumping of septic systems is the only practice in widespread use.

Shoreline Erosion Control: This control measure uses structural (e.g., riprap, revetments, etc). and/or nonstructural (e.g., marsh grass, vegetative buffers, etc.) components to reduce the direct loss of sediment into tidal waters.

Significant Point Sources: Refers to the plants included in the 1985 baseline point source nutrient loading estimate. These are publicly owned treatment works above the fall line with a design capacity of 0.5 million gallons per day (MGD) or greater and all publicly owned treatment facilities below the fall line, regardless of design capacity. Industrial plants with either nitrogen or phosphorus loads equal to or greater than the load from a 0.5 MGD treatment facility are also included in the loading estimate.

Stream Protection from Livestock: This measure requires excluding livestock from streams using fencing or other devices and providing remote watering facilities and stream crossings.

Soil and Water Quality Conservation Plans: See definition under Farm Plans.

Submerged Aquatic Vegetation (SAV): Large aquatic plants that grow permanently underwater or are exposed only at low tide. They provide food for waterfowl, sediment stabilization and shoreline erosion control, and serve as critical habitat areas for both juvenile and adult forms of many aquatic animals. A baywide reduction in SAV during the 1970s was one of the major indicators of degradation which spurred implementation of the interstate Chesapeake Bay Program.

Urban Nutrient Management: Reductions under urban nutrient management are dependent on efficiency of educational efforts to modify lawn fertilizer use by homeowners and others.

Urban BMP Retrofits: Modifying existing stormwater management facilities to enhance water quality and/or retrofitting stormwater drainage systems to add water quality components in already developed areas to slow runoff, remove sediment and nutrients, and provide a basis for restoring eroded stream channels.

Water Clarity: An ecological measure of the health of aquatic ecosystems, water clarity is a measure of light availability in the water column. Reduced water clarity can be caused by increases in phytoplankton or suspended sediments. Water clarity is the primary ecological factor controlling the growth of submerged aquatic vegetation (SAV) in the Chesapeake Bay and its tributaries.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Zooplankton Communities: Small (generally < 1mm in size) animals growing within the water column. Most remain as small organisms throughout their whole life cycle, while others represent very young stages of organisms which grow into much larger adults (e.g., fish eggs and crab larvae). A major ecological function of zooplankton is in linking the production of phytoplankton and bacteria into higher levels of the food web. The zooplankton community forms the bulk of the diet for most larval and juvenile fishes, crabs and shellfish. Because of the short life cycle of these anima1s, they respond quickly to environmental conditions and are good indicators of both short term and long term conditions.